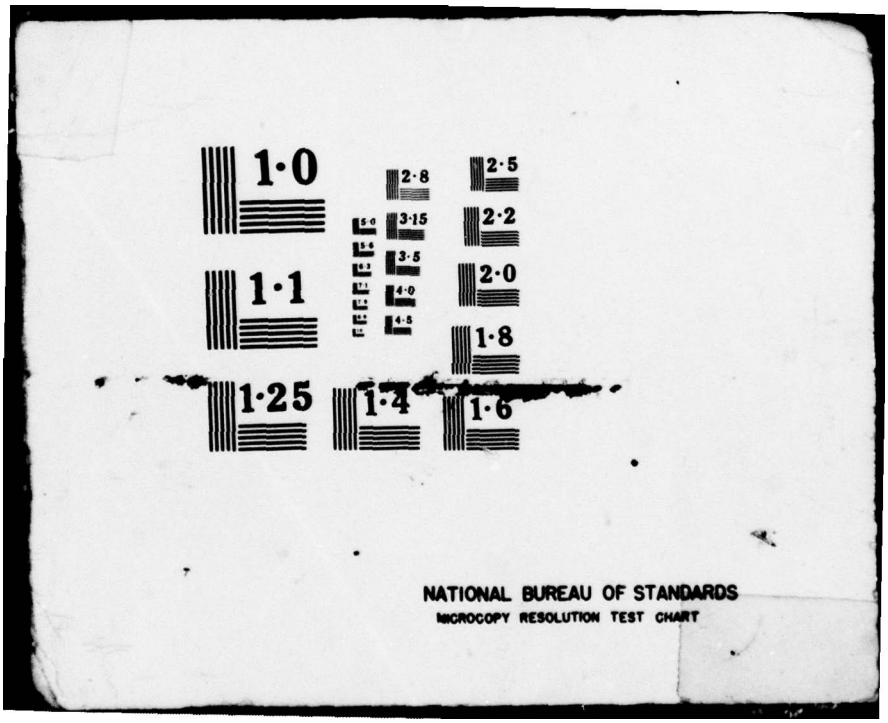
AD-A071 742 RAMCOR INC VIENNA VA F/G 4/2
A REPORT ON ATMOSPHERIC OBSTRUCTIONS TO VISIBILITY. VOLUME II. --ETC(U)
MAR 79 V J LUJETIC DAAK70-78-C-0109
UNCLASSIFIED RC168-001-VOL-2 ETL-0170 NL

1 OF 1
AD
A071742

END
DATE FILMED
8-79
DDC


1·0
1·1
1·25
1·4
1·6
2·8
3·15
3·5
4·0
4·5
2·5
2·2
2·0
1·8
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

ETL-0170

A REPORT ON ATMOSPHERIC OBSTRUCTIONS TO VISIBILITY

Volume II - Results of Literature Search

LEVEL II

RAMCOR INC.

Prepared by: Victor J. Lujetic

10 March 1979

Final Report

Prepared for

U.S. Army Engineer Topographic Laboratories
Fort Belvoir, Virginia 22060

800 FOLLIN LANE VIENNA, VIRGINIA 22180

Destroy this report when no longer needed.

Do not return it to the originator.

The findings of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The citation in this report of trade names of commercially available products does not constitute official endorsement or approval of the use of such products.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: ETL-0170	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): A Report on Atmospheric Obstructions to Visibility. Volume II, Results of Literature Search.	5. TYPE OF REPORT & PERIOD COVERED: Final Report.
6. PERFORMING ORG. REPORT NUMBER: RC 168-001 - VOL-2	
7. AUTHOR(s): Victor J. Lujetic	8. CONTRACT OR GRANT NUMBER(s): DAAK70-78-C-0109
9. PERFORMING ORGANIZATION NAME AND ADDRESS: RAMCOR, Inc. 800 Follin Lane Vienna, Virginia 22180	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Engineer Topographic Laboratories Fort Belvoir, Virginia 22060	12. REPORT DATE: 10 March 1979 13. NUMBER OF PAGES: 79
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): 88 p.	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)
Unlimited Distribution
Approved for Public Release

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
N/A

18. SUPPLEMENTARY NOTES
N/A

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Absorption	Lights	Visibility
Atmospheric	Meteorological	Visibility Instruments
Atmospheric Obstructions	Meteorological Range	Visual Detection
Attenuation Coefficients	Reflectance	Visual Range
Contrast	Scattering	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The aims and objectives of this report were to collect and assimilate information and synthesize data on the effects of atmospheric obstructions to visibility. A large part of the total study effort involved an extensive literature search and compilation of a reference and abstract bibliography related to atmospheric effects on visibility. This Volume II includes both the extensive bibliography and abstracts of selected publications related to atmospheric obstructions to visibility and related topics. The information contained in this volume was oriented to the non-specialist.

409 182

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PREFACE

This study on the atmospheric effects on visibility was performed to satisfy the requirements of government contract DAAK70-78-C-0109. This final technical report consists of two volumes:

- Volume I - Study Results, and
- Volume II - Results of Literature Search.

These two volumes are submitted per Item A002 of the Contract Data Requirements List and constitute the final technical deliverable for this contract. The Contractor Office Representative (COR) was Dr. Llewelyn Williams.

The study was oriented to the non-specialist and addressed the five required tasks of the contract. The report covered the following areas in order to achieve the aims and objectives of the study effort (where the sections apply to Volume I):

- Section 0 - Summary
- Section 1 - Nature of Light
- Section 2 - Visual Detection
- Section 3 - Obstructions to Visibility
- Section 4 - Instruments for Measurement of Visual Range
- Section 5 - Techniques for Determining Visibility
- Section 6 - List of Definitions
- Volume II - Results of Literature Search

The study findings resulted in the principal conclusion that it would be practical to develop charts and graphs that could be used to determine specific measurements of the effects of atmospheric obstructions on different types of observations and ranging devices. To illustrate this, some typical charts and graphs are included. The study also includes other conclusions and the principal recommendation that the methods presented in this study effort be refined, expanded and applied to specific situations.

TABLE OF CONTENTS

LIST OF TABLES

RESULTS OF LITERATURE SEARCH

A large part of the total study effort involved an extensive literature search and subsequent compilation of a reference and abstract bibliography related to atmospheric effects on visibility. The literature search was essentially conducted in the following manner:

- Defense Documentation Center (DDC) literature search.
  - -- Table 1 summarizes the DDC literature search number CX0476 that resulted in work unit summaries and abstracts of 76 items.
  - -- Table 2 summarizes the DDC literature search number 072300 that resulted in a report bibliography and abstracts of 603 items.
- Atlantic Research Corporation (ARC) literature search. RAMCOR initiated and completed a search of the ARC INSPEC, MET/GEOASTRO, and NTIS catalog files.
  - -- Table 3 summarizes the ARC literature search of the INSPEC file that resulted in a report bibliography and abstracts of 111 items.
  - -- Table 4 summarizes the ARC literature search of the MET/GEOASTRO file that resulted in a report bibliography and abstracts of 199 items.
  - -- Table 5 summarizes the ARC literature search of the NTIS file that resulted in a report bibliography and abstracts of 551 items.
- Special letter requests submitted to authors and organizations for reprints or copies of pertinent reports related to the study. A sample letter request is shown in Table 6.
- Literature search of other sources such as the Pentagon library, National Bureau of Standards library, NOAA library, Army library, etc.
- Personal contacts and communications with other individuals, organizations, etc.

Following this literature search, RAMCOR personnel sorted out this information into a reference list of publications and abstracts of reports on the atmospheric effects on visibility. The reference list and selected abstracts are included as part of Volume II.

It should be pointed out that there is an overwhelming amount of information related to atmospheric effects on visibility. As a result, it was not possible to review all or even a large part of this information during the course of this study. However, it is felt that some of the more important references and reports were reviewed and were made part of this study. In addition, because of the vast amount of information available, it is likely that abstracts of some important references are not included here. However, again it is felt that so many pertinent references and abstracts are included in Volume II that it is unlikely that any important aspect of the study effort is not covered.

TABLE 1

DDC LITERATURE SEARCH NUMBER CX0476

DEPARTMENT OF DEFENSE

RESEARCH AND TECHNOLOGY WORK UNIT INFORMATION SYSTEM

REPORT ON

ATMOSPHERIC OBSTRUCTIONS

DDC REPORT NO. CX0476 JUL 12, 1978

REQUESTED BY

Victor J. Lujetic, 281-1666
RAMCOR, INC.

USER CODE: 23609

PREPARED BY

DEFENSE DOCUMENTATION CENTER
FOR
SCIENTIFIC AND TECHNICAL INFORMATION
CAMERON STATION, ALEXANDRIA, VIRGINIA

TABLE 1
(Continued)

SEARCH STRATEGY

The terms below were searched by the computer. Asterisk terms represent weighted retrieval terms. Truncated retrieval terms indicate that all terms with the depicted root have been searched. Hierarchy terms are preceded by a dollar sign ($) and indicate that all terms with a hierarchical relationship to the descriptor have been searched. Coordinate searches are portrayed as search terms listed on various levels. Excluded retrieval terms are displayed under an exclude listing.

FIRST LEVEL SEARCH TERMS

Light Transmission
Obscuration
Visibility

SECOND LEVEL SEARCH TERMS

Anticyclones
Atmospheric (Truncated)
Atmospheric Condensation
Atmospheric Electricity
Atmospheric Heave
Atmospheric Motion
Atmospheric Precipitation
Atmospheric Refraction
Atmospheric Temperature
Atmospheric Tides
Barometric Pressure
Ceiling
Cirrus Clouds
Clear Air Turbulence
Cloud Cover
Clouds
Cold Fog
Coriolis Effect
Crosswind
Cumulonimbus Clouds
Cumulus Clouds
Cyclones
Dew
Dust Storms
Fog
Fronts (Meteorology)
Geostrophic Wind
Gusts
Hail
Haze
Hurricanes
Hydrometeors
Ice Fog
Jet Streams
Lapse Rate
Lightning
Meteorological Phenomena
Microbarometric Waves
Monsoons
Nimbostratus Clouds
Noctilucent Clouds
Nuclear Clouds
Rain
Sea Breeze
Snow
Snowdrifts
Snowfields
Storms
Stratus Clouds
Temperature Inversion
Thunderstorms
Tornadoes
Tropical Cyclones
Typhoons
Wind

TABLE 2

DDC LITERATURE SEARCH NUMBER 072300

A REPORT ON ATMOSPHERIC OBSTRUCTIONS, 11 July 1978

REQUESTED BY: Victor J. Lujetic, 281-1666
RAMCOR, Inc.

PREPARED BY: DEFENSE DOCUMENTATION CENTER
DEFENSE LOGISTICS AGENCY
CAMERON STATION, ALEXANDRIA, VIRGINIA 22314

SEARCH STRATEGY

The terms below were searched by the computer. Asterisk terms represent weighted retrieval terms. Truncated retrieval terms indicate that all terms with the depicted root have been searched. Coordinate searches are portrayed as search terms listed on various levels. Excluded retrieval terms are displayed under an exclude listing.

FIRST LEVEL SEARCH TERMS

Light Transmission
Obscuration
Visibility

SECOND LEVEL SEARCH TERMS

Anticyclones
Atmospheric (Truncated)
Atmospheric Condensation
Atmospheric Electricity
Atmospheric Heave
Atmospheric Motion
Atmospheric Precipitation
Atmospheric Refraction
Atmospheric Temperature
Atmospheric Tides
Barometric Pressure
Ceiling
Cirrus Clouds
Clear Air Turbulence
Cloud Cover
Clouds
Cold Fog
Coriolis Effect
Crosswinds
Cumulonimbus Clouds
Cumulus Clouds
Cyclones
Dew
Dust Storms
Fog
Fronts (Meteorology)
Geostrophic Wind
Gusts
Hail
Haze
Hurricanes
Hydrometeors
Ice Fog
Jet Streams
Lapse Rate
Lightning
Meteorological Phenomena
Microbarometric Waves
Monsoons
Nimbostratus Clouds
Noctilucent Clouds
Nuclear Clouds
Rain
Sea Breeze
Snow
Snowdrifts
Snowfields
Storms
Stratus Clouds
Temperature Inversion
Thunderstorms
Tornadoes
Tropical Cyclones
Typhoons
Wind

TABLE 3

ARC LITERATURE SEARCH OF INSPEC FILE

DIALOG FILE 12: INSPEC 69-77: USER 1835: 20 JULY 1978: 111 ITEMS

SET	ITEMS	DESCRIPTION
1	14	Atmospheric (W) Transmittance
2	71	Atmospheric (W) Transmission
3	81	Atmospheric (W) Absorption
4	50	Light (W) Attenuation
5	22	Atmospheric (W) Scattering
6	27	Radiation (W) Transmission
7	950	Light (W) Transmission
8	67502	Effects
9	96	Weather (W) Conditions
10	542	Visibility
11	1195	1+2+3+4+5+6+7
12	134	11*8
13	1	9*11
14	7	11*10
15	7	Atmospheric (W) Visibility
16	16	Transmissometer
17	7	11*16
18	1937	Aerosols
19	2977	Clouds
20	390	Fog
21	118	Water (W) Droplets
22	2220	Dust
23	0	Hazesturbulence
24	32468	Thermal
25	126	Haze
26	6645	Turbulence
27	586	Snow
28	1388	Rain
29	2397	Ice
30	363	Spray
31	2467	Air (W) Pollution
32	51205	18+19+20+21+22+24+25+26+27+28+29
33	140	32*11
34	48738	32-31
35	132	34*11
36	48	Thermal (W) Stratification
37	36	Temperature (W) Inversions
38	56	Temperature (W) Inversion
39	140	36+37+38
40	18737	32-24
41	18854	40+39
42	97	11*41
43	111	42+13+15+17+14

Atlantic Research Corp. 01835
Attn Dr. Judith K. Kitchens
Pollution Technology Section
5390 Cherokke Avenue, Alexandria, VA 22314

TABLE 4

ARC LITERATURE SEARCH OF MET/GEOASTRO FILE

DIALOG FILE 29: MET/GEOASTRO ABS 70-77: USER 1835: 20 JULY 1978: 199 ITEMS

SET	ITEMS	DESCRIPTION
1	28	Atmospheric (W) Transmittance
2	0	Atmospheric (W) Transmission
3	212	Weather (W) Conditions
4	63	Atmospheric (W) Transmission
5	86	Atmospheric (W) Absorption
6	11	Light (W) Attenuation
7	45	Atmospheric (W) Scattering
8	120	Radiation (W) Transmission
9	76	Light (W) Transmission
10	5	Atmospheric (W) Visibility
11	305	Visibility
12	13	Vision
13	10	Transmissometer
14	400	1+4+5+6+7+8+9
15	1	3*14
16	8	14*(11+12)
17	3984	Weather
18	10	17*14
19	1994	Climatic
20	840	Aerosols
21	1761	Clouds
22	554	Fog
23	65	Water (W) Droplets
24	141	Haze
25	576	Dust
26	1558	Turbulence
27	1486	Snow
28	0	Rain+Ice
29	53	Spray
30	805	Air (W) Pollution
31	1655	Thermal
32	1023	Rain
33	2182	Ice
34	8639	20+21+22+23+24+25+26+27+29+30+31
35	128	35*14
37	0	14*13
38	133	16+36
39	57	Atmospheric (W) Optics
40	56	39-38

Atlantic Research Corp 01835
Attn Dr. Judith K. Kitchens
Pollution Technology Section
5390 Cherokee Avenue, Alexandria, VA 22314

TABLE 5

ARC LITERATURE SEARCH OF NTIS FILE

DIALOG FILE 6: NTIS 64-78/I5515: USER 1835: 20 July 1978: 551 ITEMS

SET	ITEMS	DESCRIPTION
1	14	Atmospheric (W) Transmittance
2	45	Atmospheric (W) Transmission
3	39	Atmospheric (W) Absorption
4	11	Light (W) Attenuation
5	246	Atmospheric (W) Scattering
6	1890	Light (W) Transmission
7	15	Radiation (W) Transmission
8	7707	Weather
9	49	Atmospheric (W) Optics
10	2189	1+2+3+4+5+6+7+9
11	1992	Visibility
12	3145	Aerosols
13	2528	Clouds
14	1254	Fog
15	12	Water (W) Droplets
16	153	Haze
17	2070	Dust
18	5241	Turbulence
19	1774	Snow
20	991	Rain
21	3498	Ice
22	27	Thermal (W) Gradients
23	36	Thermal (W) Stratification
24	24797	8+11+12+13+14+15+16+17+18+19+20+
25	579	10*24
26	120	10*11
27	17090	24-8
28	547	27*10
29	22	Transmissometer
30	7	29*10
31	551	30+28

Atlantic Research Corp 01835
Attn Dr. Judith K. Kitchens
Pollution Technology Section
5390 Cherokee Avenue, Alexandria, VA 22314

TABLE 6

SAMPLE LETTER REQUEST

RAMCOR INC.
800 FOLLIN LANE VIENNA, VIRGINIA 22180 (703) 281-1666

1 August 1978

Your name was included in a recent "Work Unit Summaries" which we requested and which was prepared by the Defense Documentation Center, Defense Supply Agency, Alexandria, Virginia. The summaries indicate that you have conducted or are presently conducting research in one or more of the areas outlined below.

Because of a RAMCOR, Inc. contract with the U.S. Department of the Army (No. DAAK70-78-C-0109) we are interested in current and past efforts in probing the meteorological conditions of the atmosphere. The principal areas of interest include:

1) Atmospheric/meteorological attenuation of ultraviolet, visible, infrared and microwave radiation transmission.

2) The methodology (including instrumentation such as transmissometers, telephotometers, LIDAR, etc.) used in studying meteorological/atmospheric conditions.

3) Modeling of atmospheric/meteorological conditions including turbulence, temperature stratification, snow, fog, dust, rain, etc.

4) Effects of atmospheric/meteorological conditions upon instrumentation performance (e.g., variation in instrument response/sensitivity with temperature, humidity, etc. changes).

5) General effects of the atmosphere upon visibility capability and the methods employed in collecting corresponding visibility data.

We are interested in obtaining more detailed information on these topics and would appreciate your sending reprints or copies of reports (including review articles) covering your past and present work in these areas. Any additional technical information which you can supply would also be appreciated.

Thank you for your assistance in this matter.

Sincerely yours,

BIBLIOGRAPHY

A

1. Agard Conference Proceedings No. 183, (1975), Optical Propagation in the Atmosphere, NATO Advisory Group for Aerospace R&D, AGARD-CP-183.

2. Ahlquist, N.C. and Charlson, R.J., A New Instrument for Evaluating the Visual Quality of Air, Journal of the Air Pollution Control Assoc. 17, 467, 1967.

3. Ahlquist, N.C. and Charlson, R.J. (1969), Measurement of the Wavelength Dependence of Atmospheric Extinction Due to Scattering, J. Atmos. Environ. 3.

4. Allard, E., Memoire Sur l'intensite Et La Portee Des Phares, Paris, Dunod, 1376.

5. Allard E., Physique-Sur LaTransparences Des Flames Et De L'Atmosphere, Et Sur La Visibilities Des Feux Scintillants, Compte Rendues De L'Academie Des Sciences 81, 1096, 1875.

6. Allen, Robert J. and Othe, Edward E., Tactical Considerations of Atmospheric Effects on Laser Propagation, Stanford Research Institute, Menlo Park, CA, DDC-AD-855 313 (April 1969).

7. Allen, G., and Simonson, B., Attenuation of Infrared Laser Radiation by HC, FS, WP, and Fog Oil Smokes, Edgewood Arsenal Technical Report EATR 4405, May 1970.

8. Alpern, M., Movements of Eyes, in H. Davson (ed) The Eye, Vol. 3, Academic, New York, 1962.

9. Altshuler, T. L. (1961) Infrared Transmission and Background Radiation by Clear Atmospheres, GE Report 61 SD 199, AD-401923.

10. American National Standard, Nomenclature and Definitions for Illuminating Engineering, RP-16, IES/ANSI, August 1967, Revision of Z7.1-1942.

11. American Society for Testing and Materials, Nomenclature and Definitions Applicable to Radiometric and Photometric Characteristics of Matter, ASTM Special Technical Publication 475, January 1970.

12. Anderson, R. C. and Browell, E. V. (1972), First and Second-order Backscattering From Clouds Illuminated by Finite Beams. Appl. Opt. 11.

13. Anyz, F., 1964: Measurement of Water Content of Fogs in Industrial Regions, (in Russian). Studia Geophysica et Geodaetica, 8.

14. Apletalin, V. N, V.V. Meriakri, and Y.Y. Chigryay, 1970: Measurement of the Absorbing and Reflecting Properties of Water at Wavelengths from 2 to 0.8 mm, Radio Eng. Elect. Phys., 15.

15. Arnulf, A., J. Bricard, E. Cure, and C. Veret, 1957: Transmission by Haze and Fog in the Spectral Region 0.35 to 10 microns, J. Opt. Soc. Amer. 47.

16. Asano, S. and Yamamoto, G. (1975). Light Scattering by a Spheroidal Particle. Appl. Opt., 14.

17. Auer, A. H., Jr., and Veal, D. L. (1970). The Dimensions of Ice Crystals in Natural Clouds. J. Atmos. Sci. 27.

18. aufm Kampe, H. J. and Weickman, H. K. (1957). Physics of Clouds, Meteorol. Monogr. 3, No. 18. AMS, Boston.

B

19. Bailey, H.H., and L.G. Mundie, The Effects of Atmospheric Scattering and Absorption on the Performance of Optical Sensors, The Rand Corporation, RM-5938-PR, March 1969.

20. Baker, D. J. (1974), Rayleigh, the Unit for Light Radiance, Appl. Opt. 13.

21. Barnhardt, E.A. and Streete, J.L. (1970). A Method for Predicting Atmospheric Aerosol Scattering Coefficients in the Infrared. Appl. Opt. 9.

22. Baronti, P. and S. Elzweig, 1973: A Study of Droplet Spectra in Fogs. J. Atmos. Sci. 30.

23. Barteneva, O. D. and E. A. Polyakova, 1965: A Study of Attenuation and Scattering of Light in a Natural Fog Due to its Microphysical Properties. Atmos. Oceanic Phys., 1.

24. Baum, W.A. and Dunkelman, L. (1955). Horizontal Attenuation of Ultraviolet Light By the Lower Atmosphere. J. Opt. Soc. Am. 45.

25. Beggs, S.S., et al, Photometric Properties of the Atmosphere: (Industrial Haze), General Electric Co. LTD., Wembler, England, DDC-AD-895 314 (October 1942)

26. Bell, E. E. (1959). Radiometric Quantities, Symbols, and Units. Proc IRE, 47.

27. Berry, W., Review of Wartime Studies of Dark Adaptation, Night Vision Tests and Related Topics, Army-Navy-NRC Vision Committee Secretariat, Ann Arbor, December 1949.

28. Best, A.C., The Size Distribution of Raindrops. Quarterly Journal Royal Meteorological Society, Vol. 76, 1950.

29. Bestley, B., et al., The R.A.R.D.E. Portable Visibility Recorder, Royal Armament R&D Establishment, Fort Halstead, England, NTIS AD-691 588 (May 1969)

30. Bianco, A.J., E.M. D'Arcy, and J. B. Gillespie. Degradation of a Helium-Neon Laser Beam by Atmospheric Dust During a Sand Storm. ECOM-5535, March 1974.

31. Biberman, L.M. Natural Levels of Illumination and Irradiance, Photoelectronic Imaging Devices, Vol. 1. Plenum Press, N.Y. 1971.

32. Biberman, L.M., Roberts, R.E., and Seekamp, L.N., A Comparison of Electro-Optical Technologies for Target Acquisition and Guidance, IDA Paper P-1218, 1977.

33. Biberman, L.M., Effects of Weather at Hannover, Federal Republic of Germany, on Performance of Electro-optical Imaging Systems. Part I. Theory, Methodology, and Data Base, Institute for Defense Analyses, Arlington, VA., DDC-AD-A032 182 (Aug. 1976)

34. Bisyarin, V.P., I.P. Bisyarina, and A.V. Sokolov, 1971: Attenuation of 10.6 um Laser Radiation in Artificial and Real Fog. Radio Eng. Elect. Phys. 16.

35. Blackwell, H.R. (1946). Contrast Thresholds of the Human Eye. J. Opt. Soc. Am. 36.

36. Blackwell, H.R., and D.W. McCready, Jr., Foveal Detection Thresholds for Various Durations of Target Presentation, Proc. NAS-NRC Vision Committee, November, 1952.

37. Blackwell, H.R. Recent Laboratory Studies of Visual Detection, Proc. NAS-Armed Forces-NRC Vision Committee, April 1953.

38. Blaise, P., Color Vision in Maritime Signaling, Report 5-4-1, Sixth International Technical Conference on Lighthouses and Other Aides to Navigation, Washington, D. C., October 1960.

39. Blanchard, D.C. and Spencer, A.T. (1970). Experiments on the Generation of Raindrop Size Distributions by Drop Breakup. J. Stmos. Sci. 27.

40. Blau, H.H., Jr., et al. (1970). Scattering By Individual Transparent Spheres, Appl. Opt. 9.

41. Blifford, I.H., Jr., ed (1971). Particulate Models: Their Validity and Application. Publ. No. NCAR-TN/PROC-68. Boulder, Colo.

42. Blifford, I.H., Jr. and Ringer, L.D. (1969). The Size and Number Distribution of Aerosols in the Continental Troposphere, J. Atmos. Sci. 26.

43. Block Engineering, Inc., Cambridge, Mass. Airborne Infrared Transmissometer Design Study, Subsystem Design Analysis Report, DDC-AD-A009 991 (April 1975)

44. Bollay Associates, Inc., Santa Barbara, CA., Fog Droplet Growth and Precipitation-Rate Measurements with an Ultra-Violet Wavelength Transmissometer, NTIS AD-692 436 (31 July 1967)

45. Boynton, R.M., and W. R. Bush, Laboratory Studies Pertaining to Visual Air Reconnaissance, Parts I & II, Wright Air Development Center, Report TR-55-304, September 1955, April 1957.

46. Boynton, R.M., C. Ellsworth, and R.M. Palmer, Laboratory Studies Pertaining to Visual Air Reconnaissance, Part III, Wright Air Development Center, Report TR-55-304, April 1958.

47. Bradley, J.P. and Lefkowitz, M., Experiment with New Generation Ceilometers for Potential Automatic Station Use, AMS Third Symposium of Meteorological Observations and Instrumentation, Washington, 1975.

48. Brown, R.T., Jr., Backscatter Signature Studies for Horizontal and Slant Range Visibility, Sperry Rand Research Center, Rept. RD-67-24, NTIS AD-659 469 (May 1967)

49. Buchtemann, W. et. al, Experimental and Computational Comparison of Different Methods for Determination of Visual Range, AGARD Conference Proceedings No. 183, October 1975.

50. Burroughs, W. J. et. l. (1966). Transmission of Submillimeter Waves in Fog. Nature 212.

51. Byers, H. R. (1974). General Meteorology, 4th ed. McGraw-Hill, New York

C

52. Cadle, R.D. (1975). The Measurement of Airborne Particles, Wiley, New York

53. Carlon, Hugh R., A Study of Water Aerosol Absorption and Emission Effects (Including Fogs) in the 8- to 13-Micron Infrared Window, Edgewood Arnsenal, Md., DDC-AD-753345 (December 1969)

54. Cecchini, M., The Measurement of Visibility on Aerodromes, Royal Aircraft Establishment, Farnborough, England, DDC-AD-835 349 (March 1968)

55. Charlson, R.J. (1972). Multiwavelength Nephelometer Measurements in Los Angeles Smog Aerosol. In Aerosols and Atmospheric Chemistry, G. M. Hidy, ed. Academic Press, New York.

56. Chen, C.C., Attenuation of Electromagnetic Radiation by Haze, Fog, Clouds, and Rain, Rand Corporation, R-1694-PR, DDC-AD-A011 642 (April 1975).

57. Chisholm, Donald A., et.al., Airport Visibility: Its Observation Variability and Prediction, AirForce Cambridge Research Labs, Hanscom AFB, Mass., DDC-AD-A003 368 (1974)

58. Chisholm, D.A. and H.Kruse, The Variability of Visibility in the Hanscom Mesonetwork: A Preliminary Assessment, Air Force Cambridge Research Laboratories Report AFCRL-TR-74-0265, Environmental Research Paper AFCRL-ERP-479, DDC-AD-784 791 (June 1974)

59. Chu, T.S. and D.C. Hogg, 1968: Effects of Precipitation on Propagation at 0.63, 3.5, and 10.6 microns, The Bell System Tech. J., 47.

60. Clemeshaw, B.R., et.al. (1967), Laser Radar for Atmospheric Studies, J. Appl. Meteorol., 6.

61. Coleman, H.S. and Rosenberger, H.E. (1950), A Comparison of Visual and Photoelectric Measurements of the Attenuation of Brightness Contrast by the Atmosphere, J. Opt. Soc. Am., 40.

62. Collins, Dave G., Wells, Michael B., Blattner, Wolfram G., et. al., Radiation Research Associates, Inc. Fort Worth, Texas:
a. Contrast Transmission Data for Clear and Hazy Model Tropical Atmospheres, DDC-AD-848 289 (December 1968)
b. The Effects of Multiple Scattering on Backscatter Lidas Measurements in Fogs, DDC-AD-781 801 (January 1974)
c. Light Transport in the Atmosphere, Volume I: Monte Carlo Studies, NTIS-AD-650 107 (September 1966)
d. Monte Carlo Analysis of Searchlight Scattering Measurements, NTIS-AD-675 153 (31 May 1968)
e. Monte Carlo Studies of Light Transport Through Natural Atmospheres, NTIS-AD-757 494 (31 January 1973)
f. Light Transport in the Atmosphere. Volume III: Utilization Instructions for the Late Codes, NTIS-AD-650 109 (September 1966)
g. Monte Carlo Studies of Light Transport, NTIS-AD-651 815 (28 February 1967)
h. Atmospheric Path Radiance Calculations for a Model Atmosphere, NTIS-AD-668 482 (13 March 1968)
i. Light Transport in the Atmosphere. Volume II: Machine Codes for Calculation of Aerosol Scattering and Absorption Coefficients, NTIS-AD-650 108 (September 1966).

63. Collis, Ronald T.H., et.al. Visibility Measurements for Aircraft Landing Operations, Stanford Research Institute, Menlo Park, CA., DDC-AD-716483 (September 1970)

64. Cook, C.S. et.al. (1972). Remote Measurement of Smoke Plume Transmittance Using Lidar, Appl. Opt. 11.

65. Corcoran, Vincent J., Workshop on Atmospheric Transmission Modeling, Institute for Defense Analysis, Arlington, Va., DDC-AD-A026 354 (December 1975)

66. Cosden, T.H., Curcio, J.A., et.al. Atmospheric Transmission Measurement Program Report for 1 July through 30 September 1976 (TQ 1976), Naval Research Labs, Washington, D.C., DDC-AD-A046794 (September 1977).

67. Crisci, Richard L. and Lewis, Frank, Automated Probability Forecasts of Ceiling and Visibility Based on Single-Station Data, National Weather Service, Silver Spring, Maryland, DDC-AD-762 461 (February 1973)

68. Cwalinski, R. et.al. Field Testing and Evaluation of Methods for Measuring Visibility, Northwest Environmental Technology Laboratories, Inc., Bellevue, Washington, NTIS PB-251 548/4ST

D

69. Dahm, W.K., et.al., Clean Air Turbulence Detector, NASA Marshall Space Flight Center, Huntsville, Ala. NTIS N75-15028/4ST (patented 24 December 1974)

70. Danielson, R.E., et. al., The Transfer of Visible Radiation Through Clouds, J. Atmos. Sci. 26. (1969)

71. Davis, J.E., Simeroth, J.W., and Wilkerson, J.C., A Summary of Low Visibility Conditions at Arcata Airport, NBS Report 9958, November 1968.

72. deBoer, J.B., Visibility of Approach and Runway Lights, Philips Res. Rep. 6.

73. Deirmendjian, D. 1960. Atmospheric Extinction of Infrared Radiation, Quart. J. Roy Meteorol. Soc. 86.

74. Deirmendjian, D., 1964. Scattering and Polarization Properties of Water Clouds and Hazes in the Visible and Near Infrared. Appl. Opt. 3.

75. Deirmendjian, D., Far Infrared and Submillimeter Scattering. II. Attenuation by Clouds and Rain, Rand Corporation, Santa Monica, CA NTIS AD-A011 644/2ST (February 1975)

76. Deirmendjian, D., Far Infrared and Submillimeter Attenuation by Clouds and Rain, Rand Corporation, Santa Monica, CA. NTIS AD-A021 947/7ST (April 1975)

77. Dickson, D.R. and J.V. Hales, 1963. Computation of Visual Range in Fog and Low Clouds. J. Appl. Meteor. 2.

78. Donati, S. 1973: Thermal Imaging Through Hazes and Fogs in the Middle and Far Infrared Windows: Some Experimental Results. Alta Frequenza (English) 42.

79. Douglas, C.A., Methods of Modifying the Transmissometer System to Permit Its Use During Periods of Very Low Runway Visual Range, NBS Report 8188, February 1964.

80. Douglas, C.A., and Hill, A.N. Theory of the Transmissometer Photometric System, NBS Report 4558, March 1956.

81. Douglas, C.A., and Booker, R.L. (1977). Visual Range: Concepts, Instrumental Determination and Aviation Applications. Optical Physics Division, Natural Bureau of Standards, NBS Monograph 159, U.S. Dept. Of Commerce.

82. Douglas, C.A. and Simeroth, J.W., Development of Transmissometer Calibrator, NBS Report 7706, Sept. 1962.

83. Douglas, C.A. and Young, L.L., Development of a Transmissometer for Determining Visual Range, CAA Tech. Dev. Rep. No. 47, Feb. 1945.

84. Dovgyallo, Y.N., Visibility Range in the Presence of Various Meteorological Phenomena, Kanner (LEO) Associates, Redwood City, CA. NTIS N73-21525 (April 1973)

85. Dowling, James A., et.al. Atmospheric Transmission Measurement Program and Field Test Plan, Naval Research Lab, Washington, D. C., NTIS AD-A049 186/05T (30 Nov 1977)

86. Downs, A. R. A Model for Predicting the Rain Backscatter From a 70 GHz Radar. BRL Memo Report No. 2467, March 1975.

87. Downs, Alan R., A Review of Atmospheric Transmission Information in the Optical and Microwave Spectral Regions, Ballistic Research Labs, Aberdeen Proving Ground, MD, DDC-AD-A035 059 (December 1976)

88. Drummond, A.J., ed (1970). Precision Radiometry. Vol. 14 of Advances in Geophysics 1

89. Duff, Edward A., Atmospheric Contrast Transmission: Application to the Visual Detection and Electro-Optical Lock-On Problems, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, DDC-AD-743 560 (June 1972)

90. Duntley, S. Q. (1947). The Visibility of Objects Seen Through the Atmosphere. J. Opt. Soc. Am. 37.

91. Duntley, S. Q. (1948a). The Reduction of Apparent Contrast by the Atmosphere. J. Opt. Soc. Am. 38.

92. Duntley, S. Q. (1948b). The Visibility of Distant Objects. J. Opt. Soc. Am. 38.

E

93. Eggert, W.E., Approach Visibility Studies at Newark, Final Report AMB Project D-1.902, FAA, Sept 1960

94. EK (1965), How to Understand and Use Photometric Quantities, Kodak Tech Bits. No. 1, Eastman Kodak Company, Rochester, NY

95. Eldridge, Ralph G., A Comparison of Computed and Experimental Spectral Transmissions Through Haze, Mitre Corporation, Bedford, Mass. NTIS AD-676 603 (July 1968)

96. Eldridge, R.G. (1971). The Relationship Between Visibility and Liquid Water Content in Fog, J. Atmos. Sci. 28.

97. Elterman, L., UV, Visible, and IR Attenuation for Altitudes to 50 Km, Rept. AFCRL-68-0153, ARCRL, Bedford, Mass. NTIS-AD-671933 (April 1968)

98. Elterman, L. et.al. Features of Tropospheric and Stratospheric Dust, Air Force Cambridge Research Labs, Hanscom Field, Mass. NTIS AD-699 609 (16 December 1968)

99. Elterman, L. (1970b), Relationships Between Vertical Attenuation and Surface Meteorological Range, Appl. Opt. 9.

100. Ensor, D.S. et. al. (1972), Multiwavelength Nephelometer Measurements in Los Angeles Smog Aerosol. I. Comparison of Calculated and Measured Light Scattering, In Aerosols and Atmospheric Chemistry, G.M. Hidy ed. Academic Press, New York.

101. Essenwanger, O.M., 1973: On the Duration of Widespread Fog and Low Ceiling in Central Europe and Some Aspects of Predictability. U.S. Army Missile Command, Technical Report RR-73-9.

102. Essenwanger, O.M., 1973: On Spatial Distribution of Visibility and Clouds in Central Europe. U.S. Army Missile Command, Technical Report RR-73-10.

103. Essenwanger, O.M., 1977: Estimation of Absolute Humidity During Morning Fog in Central Europe. U.S. Army MIRADCOM, Technical Report TR-77-10.

104. Essenwanger, O.M., and D.A. Stewart, 1976: Fog Climatology in Central Europe and Inferred Propagation Characteristics. Proceedings of the Optical-Submillimeter Atmospheric Propagation Conference Sponsored by the Office of the Director, Defense Research and Engineering 6-9 December 1976, Vol. 1, Unclassified Papers.

105. Evans, W. E. and Collis, R. T. (1970). Meteorological Applications of Lidar, Soc. Photogr. Instr. Eng. 8

F

106. Fabre, M.R., Improvement of Visibility Over Airport Runways During Foggy Weather, Part I. Study of Fog and its Effect on Air Traffic: Procedures of Improving Visibility, Atmospheric Science Lab, White Sands Missile Range, New Mexico, DDC-AD-831 589 (February 1968)

107. Faller, Harlan L. A 50 cm Fog Disdrometer, South Dakota School of Mines and Technology, Institute of Atmospheric Sciences, Rapid City, S. D. NTIS AD-727 184 (May 1970)

108. Fante, Ronald L., Optical Beam Propagation in Turbulent Media, Air Force Cambridge Research Labs, Hanscom Field, Mass., DDC-AD-A018 061 (August 1975)

109. Fenn, Robert W., Correlation Between Atmospheric Backscattering and Meteorological Visual Range, Army Electronics Labs, Fort Monmouth, N. J. NTIS AD-604 255 (June 1964)

110. Flanigan, Dennis F. and DeLong, Harry P., Spectral Absorption Characteristics of the Major Components of Dust Clouds, Edgewood Arsenal, Maryland, NTIS AD-712 989 (September 1970)

G

111. Garland, J.A., J.R. Branson, and L. C. Cox, 1973: A Study of the Contribution of Pollution to Visibility in a Radiation Fog. Atmos. Environment 7.

112. Gathman, S.G. and R. E. Larson, 1974: Marine Fog Observations in the Arctic. Naval Research Lab. Report 7693.

113. Gazzi, M., and Vicentini, V., Visual Range of an Object in the Atmosphere, Defense Research Information Center, Orpington, England, DDC-AD-917 124 (January 1974)

114. George, D.H. Evaluation of A Sperry Lidar Ceilometer, FAA Report No. RD-74-23, February 1974.

115. Gibbons, M.G. (1959). Experimental Study of the Effect of Field of View on Transmission Measurements. J. Opt. Soc. Am. 49.

116. Gillespie, James B., and Lindberg, James D., A Method to Obtain Diffuse Reflectance Measurements from 1.0 to 3.0 micrometers Using a Cary 17I Spectrophotometer, Army Electronics Command, Fort Monmouth, N.J. NTIS AD-A035 031/4ST (November 1976)

117. Gomez, Richard B., et.al. Atmospheric Effects for Ground Target Signature Modeling. III. Discussion and Application of the ASL Scattering Model, Army Electronics Command, Fort Monmouth, N.J. DDC-AD-A009 722 (March 1975)

118. Goody, R.M. and Walker, J.C. (1972). Atmospheres, Prentice-Hall, Englewood Cliffs, N.J.

119. Green,H.N. (1932). The Atmospheric Transmission of Coloured Light. RAE Rept. E. and 1. Royal Aircraft Establishment, Farnborough, England.

120. Green, A.E. et.al.(1972). Light Scattering and the Size-Altitude Distribution of Atmospheric Aerosols. J. Colloid Interface Sci. 39.

121. Greenwood, Darryl P., et.al. AMOS (ARPA Maui Optical Station) Seeing Quality Measurements, Rome Air Development Center, Grifiss AFB, N.Y. and DARPA, Arlington, VA. NTIS AD-A021 943/6ST (January 1976)

122. Gringorten, I. I., et. al. (1966). Atmospheric Humidity Atlas - Northern Hemisphere. Rept. AFCRL-66-621. *Air Force Surveys in Geophysics* No. 186. AFCRL, Bedford, Mass.

123. Guttman, A., Extinction Coefficient Measurements on Clear Atmospheres and Thin Cirrus Clouds, General Electric Company, Missile and Space Division, Philadelphia, PA DDC-AD-828 644 (February 1968)

H

124. Hackforth, Henry L., Infrared Radiation, McGraw-Hill Book Company, Inc. 1960.

125. Hage, Keith D., and Entrekin, Herbert D., Further Studies of Space and Time Variations in Atmospheric Transmission Along Airport Runways, Travelers Research Center, Inc., Hartford, Conn., NTIS AD-617 774 (March 1965)

126. Haig, T.O. and Morton,W.C., III, An Operational System to Measure, Compute and Present Approach Visibility Information, AFCRC-TN-58-417, June 1958 (ASTIA No. AD 152584)

127. Haines, Richard F., Effects of Various Runway Lighting Parameters Upon the Relation Between Runway Visual Range and Visual Range of Centerline and Edge Lights in Fog, NASA Ames Research Center, Moffett Field, CA DDC-AD-785 320 (December 1973)

128. Halsey, H.W., and Gray, E.L., Determination of Atmospheric Transmissivity from Laser Backscatter Measurements, General Electric Company, Missile and Space Division, Philadelphia, PA, DDC-AD-715 550 (1966)

129. Hansen, J.E. and Pollack, J. B. (1970). Near Infrared Light Scattering by Terrestrial Clouds, J. Atmos. Sci., 27

130. Harris, F. S., Jr. (1972). Calculated Mie Scattering Properties in the Visible and Infrared of Measured Los Angeles Aerosol Size Distributions, Appl. Opt., 11

131. Haynes, B.C., (1947). Techniques of Observing the Weather, John Wiley & Sons, Inc. New York.

132. Heap, E., Visual Factors in Aircraft Navigation, J.Inst. Navigation (London), Vol. 18, 1965.

133. Henderson, S.T, (1970). Daylight and Its Spectrum. American Elsevier, New York

134. Hering, Wayne S., et.al. Field Test of a Forward Scatter Visibility Meter, Air Force Cambridge Research Labs, Hanscom Field, Mass. DDC-AD-726 995 (May 1971)

135. Hochreiter, F.C. and McCann,R.J., Transmissometer Calibration Techniques, FAA Report RD 68-51, September 1968.

136. Hodges, J.A. (1972). Aerosol Extinction Contribution to Atmospheric Attenuation in Infrared Wavelengths, Appl. Opt. 11

137. Hogan, A. et.al. (1975). A Portable Aerosol Detector of High Sensitivity. J. Appl. Meteorol., 14.

138. Hogg, D. C. (1964). Scattering and Attenuation Due to Snow at Optical Wavelengths. Nature, 203.

139. Hoidale, G. B. and Blanco, A. J., 1969: Infrared Absorption Spectra of Atmospheric Dust over an Interior Desert Basin, Pure Appl. Geophys. , 74

140. Horman, M.H. (1967). Visibility of Light Sources Against a Background of Uniform Luminance, J. Opt. Soc. A., 57

141. Hulburt, E. O. (1941). Optics of Atmospheric Haze, J. Opt. Soc. Am. 31

I

142. Illuminating Engineering Society, IES Lighting Handbook, Fifth Edition, New York, 197

143. Ingrao, H.C., and Lifsitz,J.R., Characteristics of a Signal Data Converter for a Multi-Runway Visibility Measuring System, Transportation Systems Center, Cambridge, Mass., NTIS AD-744 873 (October 1971)

144. Ingrao, H.C. (1973), A Bibliography on Methods of Atmospheric Visibility Measurements Relevant to Air Traffic Control and Related Subjects, Rept. No. FAA-RD-73-128, November 1973. U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.

145. Ivanov, A.I., et.al. (1969). Light Scattering in the Atmosphere, Part 2. NASA Technical Translation, Publ. No. NASA TT F-477, Springfield, VA.

J

146. James, Robert H. (Editor) et. al., National Conference on Measurements of Laser Emissions for Regulatory Purposes, HEW Publication (FDA) 76-8037, April 1976.

147. Jensen, N. (1968). Optical and Photographic Reconnaissance Systems, John Wiley and Sons, Inc., New York.

148. Jiusto, J.E., 1974: Remarks on Visibility in Fog, J. Appl. Meteor., 13.

149. Johnson, David B., Visibility Calculations for Microphysical Computer Models, Environmental Prediction Research Facility (Navy) Monterrey, CA, NTIS AD-776 228/9 (June 1972)

150. Johnson, J.C., Eldridge, R.G., and Terrell, J.R. (1954). An Improved Infrared Transmissometer for Cloud Drop Sizing. Scientific Rept. No. 4 Contract AF 19 (122)-45. Department of Meteorology, MIT, Cambridge, Mass.

K

151. Kappauf, W.E. Studies Pertaining to the Design of Visual Displays for Aircraft Instruments, Computers, Maps, Charts, Tables and Graphs: A Review of Literature (Technical Report 5765), Air Materiel Command, U.S. Air Force, April 1949.

152. Keller, R. A., Problems Encountered in the Design of a Portable Transmissometer Calibrator, FAA Report No. RD-73-7, October 1972.

153. Kerker, M. (1969). The Scattering of Light and Other Electromagnetic Radiation, Academic Press, New York.

154. Kerr, J. Richard, Multiwavelength Laser Propagation Study, Oregon Graduate Center for Study and Research, Portland, Ore., DDC AD-681 346 (December 1968)

155. Kevern, G.M., Effect of Source Size Upon Approach Light Performance, Ill. Eng. 45, 96,1950.

156. Knoll, H. A., Tousey, R., and Hulburt, E.O. (1946). Visual Thresholds of Steady Point Sources of Light in Fields of Brightness from Dark to Light. J. Opt. Soc. Am., 36

157. Kochsmeider, H. (1924). Theorie der Horizontalen Sichtweite. Beitr. Phys. Freien Atmos, 12.

158. Koopman, B. O., Search and Screening, U.S. Navy, Chief of Naval Operations, Operations Evaluation Group, Report 56, 1946.

159. Kraght, Peter E., Meteorology for Ship and Aircraft Operation, Cornell Maritime Press, New York 1942

160. Kruse, P.W., et.al. (1963). Elements of Infrared Technology. Wiley, New York.

161. Kumai, M. (1973). Arctic Fog Droplet Size Distribution and its Effect on Light Attenuation. J. Atmos. Sci., 30.

162. Kunkel, B.A., 1971: Fog Drop-Size Distributions Measured with a Laser Hologram Camera, J. Appl. Meteor., 10

L

163. Langer, R. M. Laser Beam Attenuation in the Lower Atmosphere, Bege (JRM) C, Arlington, Mass., NTIS AD-604 735 (22 November 1963)

164. LaRocca, Anthony and Turner, Robert E., Atmospheric Transmittance and Radiance: Methods of Calculation, Environmental Research Institute of Michigan, Ann Arbor, Mich., DDC-AD-A017 459 (June 1975)

165. Larsson, Alcott J., et.al. Tables of Runway Visual Range Values as a Function of Transmittance and Various Values of Pilot's Illuminance Threshold and Light Targets, FAA Systems Research & Development Service, Washington, D. C., NTIS AD-713 495 (August 1970)

166. Laufer, M. K. and Foskett, L.W., The Daytime Measurement of Cloud Heights, Journ. of the Aeronautical Sciences 8. Also J. Res. Nat. Bur. Stand. 26.

167. Lefkowitz, M., et.al. Studies in the Field of Approach Visibility Measurement and Instrumentation, FAA, Final Report, Project No. 202-2-IX, April 1962.

168. Lefkowitz, M., and Schlatter, E. E., An Analysis of Runway Visual Range, FAA Report No. RD-66-100, December 1966.

169. Leonard, D. A., An Experimental Feasibility Study of a Laser Raman Transmissometer, Research Note 915, Everett Research Laboratory (Everett, Mass.) June 1972.

170. Levi, L. (1968). Applied Optics: A Guide to Modern Optical System Design, Wiley New York.

171. Lewis, William, and Schlatter, Ernest E., Slant and Runway Visual Range Relationships, National Aviation Facilities Experimental Center, Atlantic City, N.J., DDC-AD-A041 134 (June 1977)

172. Lewis, William, Comparison of Slant and Runway Visual Range Relationships for 100, 124, and 155 feet, National Aviation Facilities Experimental Center, Atlantic City, N.J., DDC-AD-A052 870 (April 1978).

173. Lin, Chin-I, et.al. (1973). Absorption Coefficient of Atmospheric Aerosol: A Method for Measurement. Appl. Opt. 12.

174. Lindberg, James D. A Simple Method for Measuring Absolute Diffuse Reflectance with a Laboratory Spectrophotometer. ECOM-5521, November 1973.

175. Lindberg, J.D. and Laude, L.S. (1974). Measurement of the Absorption Coefficient of Atmospheric Dust. Appl. Opt. 13.

176. Lund, Iven A., An Objective Method for Alerting Forecasters of Potentially Low Visibilities at Travis AFB, California, Air Force Cambridge Research Labs, Hanscom Field Mass., DDC-AD-778 125 (1974)

M

177. Mack, E. J., R. J. Pilie, W. C. Kocmond, 1973: An Investigation of the Microphysical and Micrometeorological Properties of Sea Fog. Calspan No. CJ-5237-M-1.

178. Malysher, V. I., Study of the Transmission Spectrum of Fog in the Infrared Spectrum, General Dynamics/Astronautics, San Diego, CA., NTIS AD-668 901 (July 1959)

179. Mason, B. J. (1971). The Physics of Clouds, 2nd ed. Oxford Univ. Press, London.

180. Mason, B. J. (1975). Clouds, Rain, and Rainmaking, Cambridge University Press, Cambridge, England.

181. Mason, J., and Hoidale, G. B., Visibility As An Estimator of Infrared Transmittance Army Electronics Command, Fort Monmouth, N. J., NTIS AD-A031 040/9ST (July 1976)

182. McCartney, E. J., 1976. Optics of the Atmosphere, John Wiley and Sons, New York.

183. McClatchey, R. A., and Selby, J. E. A. (1972). Atmospheric Attenuation of HF and DF Laser Radiation, Environmental Research Paper, No. 400. AFCRL-72-0312

184. McClatchey, R. A., et. al., Optical Properties of the Atmosphere, Air Force Cambridge Research Labs, Hanscom Field, Mass., NTIS AD-753 075 (24 August 1972).

185. McClatchey, R. A., and Selby, John E. A., Atmospheric Attenuation of Laser Radiation from 0.76 to 31.25 um, Air Force Cambridge Research Labs, Hanscom Field, Mass., DDC-AD-779 726 (January 1974).

186. McClatchey J. and J. Selby. Atmospheric Transmittance from 0.25 to 28.5um: Computer Code LOWTRAN 3. AFCRL-TR-75-0255, May 1975.

187. Mellor, Malcolm, Light Scattering and Particle Aggregation in Snowstorms, Cold Regions Research and Engineering Lab, Hanover, N. H., NTIS AD-633 539 (February 1966)

188. Middleton, W. E. Knowles. Vision Through the Atmosphere. University of Toronto Press, 1958.

189. Miller, M.G. and Zieske, P.L., Turbulence Environment Characterization, AVCO Everett Research Lab, Inc., Everett, Mass., DDC-AD-A038 632 (March 1977)

190. Miller, M.G., et.al. Turbulence Environment Characterization, AVCO Everett Research Lab, Inc., Everett, Mass., DDC-AD-A052 994 (July 1977)

191. Milton, A. F., et.al. Comparison of the 3-5 Micrometer and 8-12, Micrometer Regions for Advanced Thermal Imaging Systems: LOWTRAN Revisited, Naval Research Laboratory, Washington, D. C., DDC AD-A049 448 (December 1977)

192. Mink, James W., Rain-Attenuation and Side-Scatter Measurements of Millimeter Waves over Short Paths, Army Electronics Command, Fort Monmouth, N.J., NTIS AD-A012 167/3ST (June 1975)

193. Muench, H. Stuart, et.al. Development and Calibration of the Forward Scatter Visibility Meter, AirForce Cambridge Research Lab, Hanscom Field, Mass., DDC AD-783 270 (March 1974)

194. Muench, H. Stuart, and Brown, H. Albert, Measurements of Visibility and Radar Reflectivity During Snowstorms in the AFGL Mesonet, Air Force Geophysics Lab, Hanscom AFB, Mass., DDC-AD-A049 258 (July 1977)

N

195. Nat. Bur. Stand. Visual Landing Aids Field Lab., The Determination of the Effective Intensity of Composite Light Units in Restricted Visibility, NBS Report 5644, November 1957.

196. Nat. Bur. Stand. Visual Landing Aids Field Lab., Determination of the Effective Intensity and the Visual Range of Flashing Lights in Restricted Visibility, NBS Report 5905, August 1958.

197. Nat. Bur. Stand., Instruction Book for Transmissometer Set AN/GMQ-10 NBS Report 2588, Revised January 1955.

198. National Weather Service, Sterling Research and Development Center, Videograph Calibration, Report 4-73, July 1973.

199. Naval Aviation Night Vision Instructors' Manual. NAVMED

200. Newcomb, James E., Design and Evaluation of Visibility Sensor/Runway Visual Range Computer Interface Circuitry, National Aviation Facilities Experimental Center, Atlantic City, N.J., NTIS AD-A051 175/8ST (January 1978)

201. Nichols, Thomas F. and Powers, Theordore R. Moonlight and Night Visibility. HumRRO Research Memorandum, January 1964.

202. Nicodemus, F. E. (1967). Radiometry. In Applied Optics and Optical Engineering, R. Kingslake, ed. Academic Press, New York.

203. Nicodemus, F. E. (1968). Radiometry with Spectrally Sensitive Detectors, Appl. Opt. 7

204. Night Vision for Airmen (OPNAV 33-NY-13, NAVAER 00-80T-17) Office, Chief of Naval Operations (ATD), U.S. Navy, 1944.

O

205. Oatman, L. C., Target Detection Using B/W TV, Study II: Degraded Resolution and Target Detection Probability, U.S. Army Human Engineering Laboratories, Aberdeen Proving Ground, Maryland, Report TM-10-65, July 1965

206. O'Brien, Harold W. Attenuation of Visible Light by Falling Snow, Cold Regions Research and Engineering Lab, Hanover, N. H., NTIS AD-702 905 (June 1969)

207. Oddie, G. J.W., The Transmissometer, Weather (London), 23,446,1968

208. Opticalman 1 & C, Naval Training Command/Rate Training Manual, NAVTRA #10206-A, Revision 1972.

209. Ouellette, R. J., An Extinction Coefficient Matrix for Atmospheric Transmission in the 0.32 to 0.70 Micron Wavelength Range, EG&G, Inc., Boston, Mass., DDC AD-829 393 (February 1968)

P

210. Padmos, P. and Vos, J.J., Intensity Control of Approach and Runway Lighting at Low Visibility at Night - A Theoretical Approach, Institute for Perception (Netherlands). 1974. Also Compte Rendu CIE, TC-1.6, London, 1975.

211. Parton, J. S., and J. C. Moody, Performance of Image Orthicon Type Intensifier Tubes, Proc. Image Intensifier Symposium, Fort Belvoir, Virginia, Report NASA SP-2, October 1961.

212. Pasceri, R. E. and Friendlander, S. K. (1965). Measurements of the Particle Size Distribution of the Atmospheric Aerosol. II: Experimental Results and Discussion, J. Atmos, Sci.,22.

213. Photographers Mate 3 & 2, Rate Training Manual, Bureau of Naval Personnel, NavPers #10355-A, 1971 Edition.

214. Pilie, R. J. et.al. (1975a). The Life Cycle of Valley Fog. Part I: Micrometeorological Characteristics, J. Appl. Meteorol., 14

215. Pilie, R. J. et.al. (1975b). The Life Cycle of Valley Fog. Part II: Fog Microphysics, J. Appl. Meteorol., 14.

216. Platt, C. M. (1970). Transmission of Submillimeter Waves Through Water Clouds and Fogs. J. Atmos. Sci., 27.

217. Porch, W. M. et.al. (1975). Visibility of Distant Mountains as a Measure of Background Aerosol Pollution, Appl. Opt. 14.

218. Prichard, B.S., and Elliott, W.G. (1960). Two Instruments for Atmospheric Optics Measurements, J. Opt. Soc. Am., 50

219. Projector, T.H., Effective Intensity of Flashing Lights, Ill, Eng. 52

220. Projector, T.H., The Role of Exterior Lights in Mid-Air Collision Prevention, Appl. Psychology Corp., Final Report, No. 4, July 1962

R

221. Rangarajan, S. (1972). Wavelength Exponent for Haze Scattering in the Tropics as Determined by Photoelectric Photometers. Tellus, 24.

222. Rensch, D. B. and Long, R. K. (1970). Comparative Studies of Extinction and Backscattering by Aerosols, Fog, and Rain at 10.6u and 0.63u. Appl. Opt. 9.

223. Richer, K. A., 1970. Environmental Effects on Radar and Radiometric Systems at Millimeter Wavelengths, Proc. Symposium on Submillimeter Waves, Polytechnic Institute of Brooklyn, 31 March - 2 April 1970.

224. Rinehart, G. S., and Lee, R. P., Apparent 7-Day Period in Visibility Data at White Sands Missile Range, New Mexico, ECOM-5484, April 1973.

225. Robbiani, Raymond, L., Design Concept of a Forward Area Rawinsonde Set (FARS), ECOM-5512, October 1973.

226. Roberts, R. E., 1976. Atmospheric Transmission Modeling: Proposed Aerosol Methodology with Application to the Grafenwohr Atmospheric Optics Data Base. Institute for Defense Analysis Paper P-1225.

227. Rockwell, R. James, Jr. (Editor) et.al., Optical Radiation Measurements, First Edition, Published by CDI Seminar Management, Cincinnati, Ohio, 1977.

228. Rodhe, B., 1966. The Concentration of Liquid Water in the Atmosphere Tellus, 18.

229. Rogers, C. W., E. J. Mack, U. Katz, C. C. Easterbrook, and R. J. Pilie, 1974: The Life Cycle of California Coastal Fog Onshore. Calspan Rpt No. CJ-5076-M-3 for Air Force Cambridge Research Laboratories, Cambridge, Massachusetts, AFCRL-TR-74-0419.

230. Rose, A. (1973). Vision: Human and Electronic, Plenum Press, New York.

231. Rosell, F. A., Limiting Resolution of Low-Light-Level Imaging Sensors, J. Opt. Soc. Am., Vol. 59, May 1969

232. Rosen, J. M. (1964). The Vertical Distribution of Dust to 30 km. J. Geophys. Res. 69

233. Rosen, J. M. (1968) Simultaneous Dust and Ozone Soundings Over North and Central America. J. Geophys. Res., 73.

234. Ross, S., and Warden, C. J. Visual Factors in Sighting at Dim Levels of Illumination. II. Field Tests, Journal of General Psychology, Vol. 43.

235. Ross, Richard A., LIDAR-Tracer Atmospheric Diffusion Measurement System, Deseret Test Center, Fort Douglas, Utah, DDC-AD-889 028 (August 1971)

236. Roulet, Ronald R., A Portable Spectrophotometer for Geophysical Applications, Washington University, Dept. of Atmospheric Sciences, Seattle, Washington, NTIS-AD 715 790 (December 1970)

237. Rowland, L. S., and Rowland, W. M. Individual Differences in the Region of Maximum Acuity of Scotopic Vision, AAF School of Aviation Medicine, San Antonio, February 1954.

238. Rowland, W. N., and Sloan, L. L. The Relative Merits of Red and White Light of Low Intensity for Adapting the Eye to Darkness, Journal of the Optical Society of America, Vol. 34, 1944.

239. Ruggles, Kenneth W., Environmental Support for Electro-Optics Systems, Fleet Numerical Weather Central, Monterrey, CA. DDC-AD-B004 608 (April 1975)

240. Ruppersberg, G. H. Visibility-Recording with the Scattered-Light Meter, Paper 5-2-5, Seventh International Technical Conference on Lighthouses and Other Aids to Navigation, Stockholm, June 1970.

241. Rydgren, B., Concluding Report for the FOA/MVC Study of Visibility Conditions in Connection with Landing of Aircrafts, Translation of FOA-2 Rept. A-2486-93, May 1967.

S

242. Sabin, Robert C., Visibility Improvement Graphs: A Synoptic Forecast Aid, 4th Weather Wing, Ent. AFB, Colorado, DDC-AD-697 960 (November 1969)

243. Sanderson, J. A. (1940). The Transmission of Infra-red Light by Fog. J. Opt. Soc. Am. 30.

244. Schappert, G. T., Visibility Concepts and Measurement Techniques for Aviation Purposes, Transportation Systems Center, Cambridge, Mass., DDC-AD-744 688 (July 1971)

245. Schlatter, E. E. and Lefkowitz, M., Evaluation of Multi-transmissometer Systems Final Report, FAA Report RD-68-49, August 1968.

246. Sekhon, R. S. andSrivastava, R. C. (1970). Snow Size Spectra and Radar Reflectivity. J. Atmos. Sci 27.

247. Selby, J. E. A., et.al. Atmospheric Transmittance from 0.25 to 28.5 Micrometers: Support LOWTRAN 3B, Air Force Geophysics Lab, Hanscom AFB, Mass., NTIS-AD-A040 701/5ST (November 1, 1976)

248. Setzer, D. E. Computed Transmission Through Rain at Microwave and Visible Frequencies. BSTJ. Vol. 49, 1970.

249. Shallenberger, G. D. and Little, E. M. (1940). Visibility Through Haze and Smoke, and a Visibility Meter. J. Opt. Soc. Am. 30.

250. Shapiro, J. (1974). Optimum Adaptive Imaging Through Atmospheric Turbulence. Appl. Optics 13.

251. Shurcliff, W. A. and Ballard, S. S. (1964). Polarized Light. Van Nostrand Reinhold, New York.

252. Silverman, B. A. et.al. (1964). A Laser Fog Disdrometer. J. Appl. Meteorol.3.

253. Simeroth, J. W. Horizon-Sky Brightness Produced by Airfield Lighting, NBS Report 8019, June 1963.

254. Spencer, D. E. (1960). Scattering Function for Fogs. J. Opt. Soc. Am. 50.

255. Spiro, I. J. et.al. (1965). Atmospheric Transmission: Concepts, Symbols, Units and Nomenclature. Infrared Phys. 5.

256. Stacey, J. and Arnold, J., Atmospheric Propagation in the Middle-Infrared and at 8-14 Micrometers, Technology Service Corp., Santa Monica, CA, NTIS-AD-915 878/3ST (September 28, 1973)

257. Stalenhoef, A. H. C., 1974: Slant Visibility During Fog Related to Wind Speed, Air Temperature and Stability, Arch. Meteor. Geophys. Bioklim, Ser. B.

258. Stewart, D. A., Infrared and Submillimeter Extinction by Fog, U.S. Army Missile R&D Command, Redstone Arsenal, Ala. Technical Report TR-77-9, NTIS-AD-A045 181/5ST (14 July 1977)

259. Stewart, H. S. et.al. (1949). The Measurement of Slant Visibility, NRL Rept. 3484. NRL, Washington, D. C.

260. Stewart, H. S. and Curcio, J. A. (1952). The Influence of Field of View on Measurements of Atmospheric Transmission. J. Opt. Soc. Am. 42.

T

261. Tampieri, F. and C. Tomasi, 1976b: Size Distribution Models of Fog and Cloud Droplets and Their Volume Extinction Coefficients at Visible and Infrared Wavelengths, Pure and Appl. Geophys. 114, 571-586.

262. Taylor, J. H., Visual Contrast Thresholds for Large Targets, Parts I and II. Scripps Institute of Oceanography Visibility Laboratory, Reports SIO 61-25 and 61-31, 1961.

263. Taylor and Yates, Atmospheric Transmission in the Infrared, Report on NRL Progress, pp 9-16, May 1956.

264. Tenkate, R. and Lambert's, C. W., Mie-Lidar, Physics Lab RVO-TNO, The Hague, Netherlands, NTIS-N77-10757/1ST (August 1975)

265. Thompson, W. I.,III (1971). Atmospheric Transmission Handbook: A Survey of Electromagnetic Wave Transmission in the Earth's Atmosphere over the Frequency (Wavelength) Range 3 kHz (100 km) to 3000 THz (0.1um). Rept. DOT-TSC-NASA-71-6. U.S. Department of Transportation. Cambridge, Mass.

266. Tonna, G. (1975). Microphysical Analysis of an Artificial Fog Through Laser Scattering. J. Appl. Meteorol. 14, 1547-1557.

267. Tricker, R. A. R. (1970). Introduction to Meteorological Optics. American Elsevier, New York.

268. Twomey, S. and Howell, H. B., Relative Merit of White and Monochromatic Light for the Determination of Visibility by Backscattering Measurements. Appl. Opt. 4.501,1965.

U

269. U.S. (1961). Distribution Curves of Atmospheric Transmissivity for United States Coasts. Civil Engineering Rept. 4A. United States Coast Guard, Washington, D. C. AD 25489.

270. Uthe, E. E. (1972). Lidar Observations of the Urban Aerosol Structure. Bull. Am. Meteorol. Soc. 53.

V

271. va de Hulst, H.C. (1957). Light Scattering by Small Particles, Wiley, New York.

272. Vatsia, Mishri L., Atmospheric Optical Environment, Army Electronics Command, Night Vision Lab, Fort Belvoir, Va., NTIS-AD-750610 (September 1972).

273. Vine, B. H., Electro-Optical Devices, in Applied Optics and Optical Engineering Volume 2, R. Kingslade, ed., Academic Press, New York.

274. Vogt, H. (1968). Visibility Measurements Using Backscattered Light. J. Atmos. Sci. 25.

275. Volz, F. E. et.al. Optical Properties of the Atmosphere (Revised), Air Force Cambridge Research Labs, Hanscom Field, Mass, DDC-AD-726 116.

276. Volz, F. E., Infrared Absorption by Atmospheric Aerosol Substances, J. Geophys. Res., 77 No. 6, 1972.

277. Volz, F. E. (1973). Infrared Optical Constants of Ammonium Sulfate. Sahara Dust, Volcanic Pumice, and Flyash. Appl. Opt. 12.

278. Volz, F. E. (1970c). Spectral Skylight and Solar Radiance Measurements in the Caribbean: Maritime Aerosols and Sahara Dust, J. Atmos. Sci., 27.

279. Vos, J. J., A. Lazet, and M. A. Bouman, Visual Contrast Thresholds in Practical Problems, J. Opt. Soc. Am., Vol. 46, 1956.

280. Vroombout, Leo Owen. Long Path, Visible and Infrared Transmissometer: Calibration and Use, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, NTIS AD-A052 898/4ST (October 1977)

W

281. Waggoner, A. P. et.al. (1972). Measurement of the Aerosol TotalScatter-Backscatter Ratio. Appl. Opt., 11.

282. Warden, C. J. Visual Factors in Sighting at Dim Levels of Illumination. I. Laboratory Studies, Journal of General Psychology, Vol. 42, 1950.

283. Waters, R. H., and Reynolds, R. R., Analysis and Modification of RVR Equipment for RVR Values 500 Feet and Above, FAA, Final Report No. RD-66-34, May 1966.

284. Whitby, K. T. (1971). Aerosol Measurements: New Data on Urban Aerosols and Formation Mechanisms. In Particulate Models: Their Validity and Application. I. H. Blifford, Jr., ed, NCAR-TN/PROC-68, NCAR, Boulder, Colo.

285. Whitby, K. T. et.al. (1972a). The Minnesota Aerosol Analyzing System Used in the Los Angeles Smog Project. J. Colloid Interface Sci., 39

286. Whitby, K. T. et.al. (1972b). The Aerosol Size Distribution of Los Angeles Smog. J. Colloid Interface Sci., 39. Also in Aerosols and Atmospheric Chemistry, G. M. Hidy, ed. Academic Press, New York.

287. White, Kenneth O., James B. Gillespie, Robert Armstrong, and Larry E. Traylor, State-of-the-Art Survey of Meteorological Instrumentation Required to Determine Atmospheric Effects on Airborne Laser Tests, ECOM-5469, January 1973.

288. Wilkniss, P. E. et.al. (1975). CO, CCl, CO, CCl_4, Freon 11, CH_4, and Rn-222 Concentrations at Low Altitudes Over the Arctic Ocean in January 1974. J. Atmos. Sci.,32.

289. Williams, C. S. and Becklund, O. E. (1972). Optics: A Short Course for Engineers and Scientists, Wiley, New York.

290. Williams, Jerome, The Meaningful Use of the Secchi Disc, Johns Hopkins Univ., Chesapeake Bay Institute, Baltimore, Md. NTIS-AD-679 166 (November 1968).

291. Wilson, R. W. and Penzias, A. A. (1966). Effect of Precipitation on Transmission Through the Atmosphere. Nature, 211.

292. Winstanely, J. V. and Adams, M. J. (1975). Point Visibility Meter: A Forward Scatter Instrument for the Measurement of Aerosol Extinction Coefficient. Appl. Opt. 14.

293. Witte, H. J. (1968). Airborne Observarions of Cloud Particles and Infrared Flux Density (8-14 um) in the Arctic. Scientific Rept. On Contract NOnr 477(24) (NR 307-252). University of Washington, Seattle, AD-679 241. NTIS, Springfield, VA.

294. WMO (1973a). Compendium of Meteorology, Vol. 1, Part 1: Dynamic Meteorology. Publication WMO 364. World Meteorological Organization. Unipub. New York.

295. WMO (1973b). Compendium of Meteorology, Vol. 1, Part 2: Physical Meteorology. Publication WMO 364, World Meteorological Organization. Unipub. New York.

296. World Meteorological Organization, Guide to Meteorological Instrument and Observing Practices, Chapter 10 - Measurement of Visibility, 1971.

297. Wright, A. D. The Performance of Ground Observers in Detecting, Recognizing and Estimating Range to Low-Altitude Aircraft, HumRRO Technical Report 66-19, December 1966.

Z

298. Zelmanovich, I. L, et.al., Calculation of the Attenuation Coefficients of 0.6-14 Micrometer Waves Passing Through Fog, Foreign Technology Div., Wright-Patterson AFB, Ohio, NTIS-AD-714 786 (8 September 1970).

299. Zuev, V. E. (1974). Propagation of Visible and Infrared Waves in the Atmosphere, Halsted Press, New York.

300. Zuev, V. E., Atmospheric Transparency in the Visible and the Infrared, Translated from Russian, National Science Foundation, Washington, D. C. NTIS-TT-69-55102 (1970).

ABSTRACTS

OF SELECTED PUBLICATIONS

TITLE/SOURCE :

(a) Contrast Transmission Data for Clear and Hazy Model Tropical Atmospheres, DDC-AD-848 289 (December 1968)

(b) The Effects of Multiple Scattering on Backscatter Lidar Measurements in Fogs, DDC-AD-781 801 (January 1974)

(c) Light Transport in the Atmosphere. Volume I: Monte Carlo Studies, NTIS-AD-650 107 (September 1966)

(d) Monte Carlo Analysis of Searchlight Scattering Measurements, NTIS-AD-675 153 (31 May 1968)

(e) Monte Carlo Studies of Light Transport Through Natural Atmospheres, NTIS-AD-757 494 (31 January 1973)

(f) Light Transport in the Atmosphere. Volume III: Utilization Instructions for the Lite Codes, NTIS-AD-650 109 (September 1966)

(g) Monte Carlo Studies of Light Transport, NTIS-AD-651 815 (28 February 1967)

(h) Atmospheric Path Radiance Calculations for a Model Atmosphere, NTIS-AD-668 482 (13 March 1968)

(i) Light Transport in the Atmosphere. Volume II: Machine Codes for Calculations of Aerosol Scattering and Absorption Coefficients, NTIS-AD-650 108 (September 1966)

AUTHOR: Collins, Dave G.; Wells, Michael B.; Blattner, Wolfram G.; et al.
Radiation Research Associates, Inc., Fort Worth, Texas

ABSTRACT: These publications address a number of atmospheric related efforts concerning Monte Carlo data and related topics. These Monte Carlo programs and codes include LITE-I, LITE-II, LITE-III, LITE-IV, FLASH, BRITE, FLARE, TPART-I, MIE1, MIE2, MIE3, MIE4, and MIE5. These programs and codes were generated to perform the following:

- Scattering of light in clear and hazy atmospheres
- Computation of atmospheric contrast transmission data
- Effect of multiple scattering in the atmosphere
- Computation of light transmission for point and plane surfaces
- Analysis of the measurement of scattered light from a searchlight beam
- Procedures for calculating scattering in the atmosphere

TITLE: Tactical Considerations of Atmospheric Effects on Laser Propagation

AUTHOR: Allen, Robert J.; Uthe, Edward E.
Stanford Research Institute, Menlo Park, CA

SOURCE: DDC-AD-855 313 (April 1969)

ABSTRACT: The pertinent findings of a three-year study of the effects of the atmosphere on laser propagation are presented, primarily in connection with the Remote Target Designator and Target Illumination System. In addition to data in support of the basic design of tactical weapon systems, this study has also produced information concerning available methods and techniques with which to determine the probability of completing a mission successfully by inferring atmospheric transmission properties at the 1.06-micrometer laser wavelength from on-the-spot observations. It is shown that this is best implemented by adding lidar (laser radar) capabilities to the target designator/illuminator. This addition would also permit atmospheric transmission to be determined at night, would eliminate human error and the need for specialized training, and would provide a more precise determination of atmospheric transmission in space and time coordinates. The nature of Mie scattering as investigated using Fourier techniques is reported. These studies have provided a better insight into how atmospheric scattering properties can be generally described if it is shown that empirical backscatter-extinction relations may exist for highly absorbing Mie particles, or for non-Mie particles regardless of the particle-size distribution. (Author)

TITLE: Photometric Properties of the Atmosphere: (Industrial Haze)

AUTHOR: Beggs, S. S.; Monks, G. K.; Morse, J. W.; Waldram, J. M.
General Electric Company, Ltd., Wembler, England

SOURCE: DDC-AD-895 314 (October 1942)

ABSTRACT: This report records in detail experiments in industrial haze made from a balloon in Birmingham and Coventry. Measurements have been made of the distribution of scattered light, and also an estimate of the absorption coefficient at various heights and the air-ground transmission to various heights up to 2000 or 2500 ft.

TITLE: Slant and Runway Visual Range Relationships

AUTHOR: Lewis, William; Schlatter, Ernest E.
National Aviation Facilities Experimental Center, Atlantic City, NJ

SOURCE: DDC-AD-A041 134 (June 1977)

ABSTRACT: A study was conducted to determine if any significant relationships existed between horizontal and slant visibility during fog conditions. Approximately 11,000 sets of atmospheric transmittance observations in fog were obtained at six horizontal levels from 5 to 155 feet and from the 5- to 155-foot slant path by extinction-type transmissometers mounted on two airfield towers separated by 250 feet. Each observation set was classified into one of seven vertical profile classes according to the transmittance difference between the top (155-foot) and bottom (5-foot) transmissometers. The implications of the various fog structures for aircraft landings are discussed. Average 5- to 155-foot slant visual range versus 5- foot runway visual range (SVR-RVR) ratios and standard deviations of ratios were computed by profile class. An analysis showed that results are definitive and could form the basis of a procedure for estimating SVR from RVR through fog profile measurement. A multiple linear regression analysis to predict SVR from RVR, surface temperature, wind speed, and atmospheric stability showed RVR to be the best predictor of SVR, while the other variables showed some effect only with dense fog. These results are considered tentative, since they are based on a limited data sample. Fifteen-minute changes in SVR by profile class were examined for certain SVR ranges. Results showed that knowledge of the profile class would not significantly improve.

TITLE: Improvement of Visibility Over Airport Runways During Foggy Weather. Part 1. Study of Fog and its Effect on Air Traffic: Procedures of Improving Visibility

AUTHOR: Fabre, M. R.
Atmospheric Science Lab, White Sands Missile Range, New Mexico

SOURCE: DDC-AD-831 589 (February 1968)

ABSTRACT: Contents: The formation of fog; Determination of visual depth in fog; Conditions and methods of improving visibility over airports; Study of fog dissipation carried out abroad.

TITLE: Multiwavelength Laser Propagation Study

AUTHOR: Kerr, J. Richard
Oregon Graduate Center for Study and Research, Portland, Ore.

SOURCE: DDC AD-681 346 (December 1968)

ABSTRACT: The major objective of this program is to experimentally investigate the wavelength-dependence of turbulence effects on optical propagation through the atmosphere, and to relate the results to certain meteorological parameters, theoretical models, and model-independent dimensional analyses. The experiments are conducted with the use of simultaneous, spatially-coincident laser beams at three wavelengths in the visible and infrared spectrum, with real-time processing for the various statistical results. During the second period, the low noise, stable lasers were acquired, the three-wavelength transmitter and receiver optical systems were constructed, and the computer electronics were completed. A newly acquired, flat site was established with necessary power, cooling, communications, and protective arrangements. The above systems are currently being installed at the site. The resultant facility will be uniquely suited to atmospheric propagation work, in terms of multiwavelength capability, data processing versatility, meteorological instrumentation, and attention to experimental detail necessary to achieve reliable results in this difficult field of investigation. (Author).

TITLE: Visual Range of an Object in the Atmosphere

AUTHOR: Gazzi, M.; Vicentini, V.
Defence Research Information Center, Orpington, England

SOURCE: DDC-AD-917 124 (January 1974)

ABSTRACT: This article briefly demonstrates the elementary principles which form the basis of vision in the atmosphere. Visual range, elementary theory of vision, attenuation and light of the atmosphere, contrasts threshold, and calculation of visual range are all considered. (Author)

TITLE: Turbulence Environment Characterization

AUTHOR: Miller, M.G.; Zieske, P.L.
Avco Everett Research Lab, Inc., Everett, Mass.

SOURCE: DDC-AD-A038 632 (March 1977)

ABSTRACT: This report covers some aspects of our investigations of atmospheric turbulence as it relates to the propagation of electromagnetic waves. The major emphasis in this report is a presentation and discussion of data obtained during the last year with a variety of experimental systems deployed at the ARPA Maui Optical Station (AMOS) atop Haleakala on the island of Maui, Hawaii. A brief discussion of the operational aspects and status of the instrumentation is also included. Estimates of the correlation scale, r sub o, were obtained on 24 nights (a total data set of 228 points) using the Seeing Monitor. The measured mean value is 9.6 cm with a range of (5.3 - 17.8) cm at 5000 A. The uncertainty in the measurements is estimated to be of order (5-10)%. Absolute calibration of the entire system is the major uncertainty. A variety of effects including trends and apparent nonstationarity effects were observed. Estimates of high altitude turbulence profiles obtained with the Star Sensor indicate a flattening and in some cases an increase in turbulent strength in the vicinity of the meteorological tropopause. Log-Amplitude device have a mean value of 0.00058 and a range of 0.00015-0.00028. Nonstationarity effects were often observed. Comparative and simultaneous scintillation measurements show good agreement.

TITLE: Environmental Support for Electro Optics Systems

AUTHOR: Ruggles, Kenneth W.
Fleet Numerical Weather Central, Monterrey, CA

SOURCE: DDC-AD-B004 608 (April, 1975)

ABSTRACT: Environmental effects on Electro-Optical systems are described, and the impact of these effects are crudely assessed. From this discussion, environmental support requirements are developed. The state of the science in responding to requirement is reviewed, and recommendations are made for a Navy research and environmental support program. (Author)

TITLE: Airport Visibility: Its Observation, Variability and Prediction

AUTHOR: Chisholm, Donald A.; Hering, Wayne S.; Muench, H. Stuart
Air Force Cambridge Research Labs., Hanscom AFB, Mass.

SOURCE: DDC-AD-A003 368 (1974)

ABSTRACT: New techniques for visibility observation, variability analysis and prediction are being explored and tested as part of an experimental mesoscale prediction program now underway at the Air Force Cambridge Research Laboratories. A new visibility meter, the forward scatter visibility meter (FSM) developed by EB and B, Inc., has been found to be highly correlated (0.98) to nearby transmissometer observations, very reliable and stable, and subject to minimal calibration drift (1-3 percent) based on over two years of nearly continuous use at some mesonetwork stations. An analysis of the temporal and spatial (horizontal and vertical) variability of visibility during different types of restrictions (precipitation, radiation fog, advection fog) has been conducted with observations taken at three locations along the runway and on towers into alternative means of describing prevailing visibility, runway visual range, and slant visual range in airport environs will be discussed. Enlarging the temporal and spatial variability analysis to include the entire network permits an evaluation of the prediction potential of mesonetworks over and above conditional climatology in short range (15 to 60 minute) airport visibility forecasting. (Author)

TITLE: The Measurement of Visibility on Aerodromes (Measure De La Visibilite Sur Les Aerodromes)

AUTHOR: Cecchini, M.
Royal Aircraft Establishment, Farnborough, England

SOURCE: DDC-AD-835 349 (March 1968)

ABSTRACT: The note lists the various factors affecting the visual range of lights in fog and points out the variability of ranges measured by human observers. An alternative method of visual range estimation using transmissometers is explained and leads to a description of an apparatus designed by La Compagnie des Compteurs which accepts transmissometer outputs, converts the signals to RVR and displays the reading to Air Traffic Controllers on an airfield. (Author)

TITLE: Measurements of Visibility and Radar Reflectivity during Snowstorms in the AFGL Mesonet

AUTHOR: Muench, H. Stuart; Brown, H. Albert
Air Force Geophysics Lab., Hanscom AFB, Mass.

SOURCE: DDC-AD-A049 258 (July, 1977)

ABSTRACT: Field experiments were conducted with the AFGL Mesonet and FPS-77 digital radar during snowstorms for evaluation of the use of radar to observe and predict snow. Simultaneous measurements of optical extinction coefficient, radar reflectivity, and snow depth were made, together with determinations of visual range. The measurements verify both the calibration of the visibility instruments and the relationship between visual range and extinction coefficient. A relationship found between extinction coefficient and snowfall rate compares well with relationships found by other investigators. Radar reflectivity is found to be related to extinction coefficient, with the correlation being improved by time averaging and by allowance for velocity of snowflakes from the radar beam to the ground. However, the specification errors are of the order of + or - 42 percent to + or - 65 percent, and with the small spatial and temporal variability of extinction coefficient in snow, the radar is of marginal use where observations are available from the airways network. (Author)

TITLE: Turbulence Environment Characterization

AUTHOR: Miller, M. G.; Zieske, P. L.; Sofia, A. J.; Pepe, R. J.
Avco Everett Research Lab, Inc., Everett, Mass.

SOURCE: DDC-AD-A052 994 (July, 1977)

ABSTRACT: This report contains discussions of a variety of activities and results relative to the characterization of atmospheric turbulence and its effects on optical propagation at the DARPA AMOS Observatory on Maui, Hawaii. Work carried out during this reporting period has included: (1) deployment and testing of new and/or modified instrumentation; (2) routine data collection; (3) special experiments for instrument characterization and calibration, and, (4) theoretical and statistical analysis of the resulting data.

TITLE: A Review of Atmospheric Transmission Information in the Optical and Microwave Spectral Regions

AUTHOR: Downs, Alan R.
Ballistic Research Labs., Aberdeen Proving Ground, Md.

SOURCE: DDC-AD-A035 059 (December 1976)

ABSTRACT: Much information has been generated over a long period of time on the transmission through the atmosphere of radiation of various wavelengths. This report represents an attempt to consolidate some of the available information into a single report. This report addresses five wavelengths each in the optical and microwave regions. Attenuation mechanisms considered are Rayleigh and Mie scattering and absorption by both water vapor and water drops. Atmospheres characterized by visibilities between 0.1 km (fog) and 325 km (clean air) and by rainfalls at rates up to 64 mm/hr are considered. Pertinent formulations and tables are provided to assist in calculating attenuation coefficients characteristic of a wide variety of atmospheres, and the adequacy of the data bases upon which such calculations rest is assessed. A limited amount of information is also provided on the attenuation characteristics of smoke and dust. (Author)

TITLE: Attenuation of Electromagnetic Radiation by Haze, Fog, Clouds and Rain

AUTHOR: Chen, C. C.
Rand Corporation, Santa Monica, Ca.

SOURCE: DDC-AD-A011 642 (April 1975)

ABSTRACT: The report assembles, under one cover, the values of aerosol attenuation coefficients of regions in the electromagnetic (EM) spectrum containing so-called 'atmospheric windows,' in which EM radiation suffers the least amount of atmospheric gaseous absorption. The purpose is to enable rapid quantitative assessment of target acquisition terminal guidance sensors using the windows during adverse weather. Both calculated and available measured values are presented. Being a compilation drawn from numerous sources, the report is intended more as a handbook for ready use than as a theoretical treatise.

TITLE: Effect of Weather at Hannover, Federal Republic of Germany, on Performance of Electrooptical Imaging Systems. Part 1. Theory, Methodology, and Data Base.

AUTHOR: Biberman, Lucien M.
Institute for Defense Analyses, Arlington, VA

SOURCE: DDC-AD-A032 182 (August 1976)

ABSTRACT: This paper examines the effect of weather on the probability of electrooptical detection of tanks at various ranges. The paper employs actual weather data recorded hourly at Hannover, Federal Republic of Germany, for a full year (1970) and a mathematical model of the electro-optical detection/recognition process developed by R. L. Sendall and L. M. Biberman from the perceived signal-to-noise concept of F. A. Rosell. The mathematical model makes use of a slightly modified version of the LOWTRAN 3 atmospheric transmittance model developed by the Air Force Geophysics Laboratory. The results show a wide variability in the probability of detection caused by wide and frequent variations in the weather. (Author).

TITLE: Optical Beam Propagation in Turbulent Media

AUTHOR: Fante, Ronald L.
Air Force Cambridge Research Labs, Hanscom AFB, Mass.

SOURCE: DDC-AD-A018 061 (August 1975)

ABSTRACT: The most recent developments on the propagation of microwave and optical beams in turbulent media, such as the clear atmosphere are discussed. Among the phenomena considered are beam spreading, beam wander, loss of coherence, scintillations, angle-of-arrival variations, and short pulse effects. Also included is a discussion of methods of compensation of the effect of turbulence on communications and imaging systems.

TITLE: An Extinction Coefficient Matrix for Atmospheric Transmission in the 0.32 to 0.70 Micron Wavelength Range

AUTHOR: Ouellette, R. J.
EG&G, Inc., Boston, Mass.

SOURCE: DDC-AD-829 393 (February 1968)

ABSTRACT: This report describes a method for evaluating atmospheric transmittance in the 0.32-0.70 micron wavelength band for arbitrary locations of source and receiver in the 0-700 km altitude range. The formulation utilizes a detailed matrix of extinction coefficients as a function of wavelength and altitude, and includes (1) molecular (Rayleigh) scattering, (2) ozone absorption, (3) aerosol scattering, and (4) water vapor absorption. Input data appropriate to the Dominic high altitude series are given special attention, and extinction coefficients for Starfish, Kingfish, and Checkmate are tabulated in the appendix. These coefficients and the atmospheric model are to be used to calculate transmission for Dominic events only when actual transmission measurements are lacking. The transmission matrix presented in this report for the 0-50 km altitude range is nearly the same as that reported by Elterman in 'Handbook of Geophysics and Space Environment' (1965). In the 50-60 km altitude range, the total extinction coefficient is made up of ozone absorption (obtained by extrapolation from lower altitudes) and calculated Rayleigh scattering.

TITLE: Comparison of the 3-5 Micrometer and 8-12 Micrometer Regions for Advanced Thermal Imaging Systems: LOWTRAN Revisited

AUTHOR: Milton, A. F.; Harvey, G. L.; Schmidt, A. W.
Naval Research Laboratory, Washington, D.C.

SOURCE: DDC-AD-A049 448 (December, 1977)

ABSTRACT: Four spectral bands for advanced infrared imaging systems are compared on the basis of calculations of atmospheric transmission, using the LOWTRAN 3B atmospheric transmission model. Slant paths, MTF effects, and Maritime and Rural aerosol models are included in the analysis. The relative advantage of the 3- to 5-micrometer band is shown to be strongly influenced by the choice of aerosol models. (Author)

TITLE: Atmospheric Transmittance and Radiance: Methods of Calculation

AUTHOR: LaRocca, Anthony J.; Turner, Robert E.
Environmental Research Institute of Michigan, Ann Arbor, Mich.

SOURCE: DDC-AD-A017 459 (June 1975)

ABSTRACT: The report is broadly divided into the categories of scattering and absorption, with the greater stress laid on absorption. The first of these is the socalled line-by-line direct integration method, which requires a detailed compilation of the characteristics of individual molecular lines. The second of the absorption methods of calculation presented is the band-model technique. In this method, the line spectrum is approximated by some mathematically manipulatable distribution function with undetermined band-model parameters. By comparison of calculated results with laboratory experimental data the parameters are defined, and the band-model is used for calculating transmittance under any required meteorological conditions. The third general set of techniques is given the heading 'Multi-Parameter Analytical Procedures.' These techniques are derived from the band-model concept, incorporating a larger number of parameters, with presumably greater accuracy in the resultant calculations.

TITLE: Optical Properties of the Atmosphere (Revised)

AUTHOR: Volz, F. E.; Garing, J. S.; McClatchey, R.A.; Fenn, R.W.
Air Force Cambridge Research Labs., Hanscom Field, Mass.

SOURCE: DDC-AD-726 116

ABSTRACT: A series of tables and charts is presented from which the atmospheric transmittance between any two points in the terrestrial atmosphere can be determined. This material is based on a set of five atmospheric models ranging from tropical to arctic and two aerosol models. A selected set of laser frequencies has been defined for which monochromatic transmittance values have been given. For low resolution transmittance prediction, a series of charts has been drawn providing the capability for predicting transmittance at a resolution of 20 wavenumbers. Separate sections are included on scattered solar radiation, infrared emission, refractive effects, and attenuation by cloud and fog. (Author)

TITLE: LIDAR-Tracer Atmospheric Diffusion Measurement System

AUTHOR: Ross, Richard A.
Desert Test Center, Fort Douglas, Utah

SOURCE: DDC-AD-889 028 (August 1971)

ABSTRACT: Development of the Raman LIDAR (Laser Radar) system has realized marked progress in recent months. It will provide a unique method for determining the composition and concentration of atmospheric constituents as small as gas molecules. Thus, this system will not only provide a method for monitoring the status of the atmosphere but also provide instantaneous portrayals of changes of the density of a portion of a tracer cloud, as well as identify the content of the cloud. This is most easily accomplished by utilizing the phenomenon of Raman scattering in conjunction with an appropriate tracer cloud. A Raman LIDAR system would allow an indirect measurement of turbulent diffusion processes, concentration profiles, and composition identification that would be orders of magnitude better than the existing standard field sampler techniques. Employing information from such a system would allow the computation of such things as downwind hazard prediction with marked improvement in the precision because of the higher grade data which would incorporate continuous real time sampling from a sensor located at a site remote from the tracer cloud. (Author).

TITLE: Atmospheric Contrast Transmission: Application to the Visual Detection and Electro-Optical Lock-On Problems

AUTHOR: Duff, Edward Aloysius
Air Force Institute of Technology, Wright-Patterson AFB, Ohio

SOURCE: DDC-AD-743 560 (June 1972)

ABSTRACT: Models for the prediction of detection range are evaluated in this report. The contrast available at the eye or the electro-optical sensor is assumed to be the limiting factor. The atmosphere provides a transmission factor for the target-background contrast. A model for the prediction of contrast transmission proposed by Duntley in 1948 is examined. Duntley's work provides an analytic solution based on an equation which relates visibility to air-transmittance along an inclined path, and a table of sky-ground ratios. An improved relation for visibility is developed by the author. More realistic sky-ground ratios are obtained from calculated data and from flight tests. (Author)

TITLE: Automated Probability Forecasts of Ceiling and Visibility Based on Single-Station Data

AUTHOR: Crisci, Richard L.; Lewis, Frank
National Weather Service, Silver Spring, MD

SOURCE: DDC-AD-762 461 (February 1973)

ABSTRACT: A set of computer programs was developed to produce multiple linear regression equations for predicting the probability of specified ceiling and visibility categories at air terminals. The equations were based upon weather observations made solely at the terminal and were derived with the REEP screening technique from 329 possible predicators. The program(s) accepted raw data in a standard National Climatic Center format, and a complete set of prediction equations for five time projections was produced for each of 50 stations in a single computer run. The accuracy of forecasts generated by the equations was evaluated for 20 terminals. Three measures of accuracy were used to compare the objective forecasts to persistence and climatology. Computer programs were developed to prepare forecasts on an operational basis for 20 terminals in the eastern U.S. and 23 terminals in Alaska. (Modified author abstract)

TITLE: Visibility Concepts and Measurement Techniques for Aviation Purposes

AUTHOR: Schappert, G. T.
Transportation Systems Center, Cambridge, Mass.

SOURCE: DDC-AD-744 688 (July 1971)

ABSTRACT: The report reviews present techniques for measuring atmospheric transmittance and its conversion to runway visual range. The response of the pilot to visual cues used in determining the visibility is discussed as a function of his cockpit environment. The lights used by the FAA as targets for visibility determinations are discussed and used in the computations. New techniques for visibility measurements and new concepts and definitions are discussed and analyzed. The emphasis is on techniques for measuring slant visual range by means of optical remote sensing devices. Various problems relating to atmospheric modeling, signal processing, and eye safety aspects are discussed. (Author)

TITLE: A Study of Water Aerosol Absorption and Emission Effects (Including Fogs) in the 8- to 13-Micron Infrared Window

AUTHOR: Carlon, Hugh R.
Edgewood Arsenal, MD

SOURCE: DDC-AD-753 345 (December 1969)

ABSTRACT: Water aerosols theoretically are capable of very strong absorption and emission in the 8 micrometers to 13 micrometers infrared atmospheric window, owing to the 10,000 increase in the absorptivity of water in this spectral region for the liquid phase as compared to that for water vapor. The author reviews his earlier papers in light of subsequent developments reported in the literature and finds strong evidence for water aerosol activity in measurements relating to atmospheric transmission, radiance, and turbulence. Several examples are given of experimental increases in optical activity of the atmosphere with relative humidity increases, even though absolute humidities (reflecting water vapor concentrations normally stated to cause similar effects owing to wing absorption of distant lines) are quite constant. Availability and suitability of condensation nuclei are thought to be significant in determining the degree of water aerosol absorption and emission. Emission effects are most pronounced. (Author)

TITLE: Statistics of Global IR Atmospheric Transmission

AUTHOR: Modica, Anthony P.; Kleiman, Herbert
MIT, Lincoln Lab., Lexington, Mass.

SOURCE: DDC-AD-A024 311 (March 1976)

ABSTRACT: RAND weather data tapes have been used to obtain statistics of visibility, relative humidity and cloud ceiling heights for weather stations throughout the Northern Hemisphere to generate global probabilities for atmospheric attenuation in the infrared spectral region. The present analysis predicts seasonal probabilities for horizontal sea level transmission losses for several narrow IR bands (1.0-1.2), (3.8-4.2), (8.0-11.5 micrometers) and four laser lines (1.06), (3.83), (4.73) and 10.6 micrometers). The results also include cloud-free-line-of-sight probabilities and attenuation losses through rain. (Author)

TITLE: Field Test of a Forward Scatter Visibility Meter

AUTHOR: Hering, Wayne S.; Muench, H. Stuart; Brown, H. Albert
Air Force Cambridge Research Labs., Hanscom Field, Mass.

SOURCE: DDC-AD-726 995 (May 1971)

ABSTRACT: Field tests of a forward scatter visibility instrument were carried out in August 1970 at Cutler, Maine. The performance characteristics of the new instrument were examined through comparisons of simultaneous measurements of atmospheric extinction coefficient with a conventional transmissometer and through comparisons with human observations of visibility. During periods of dense coastal advection fog, which restricted visibility to less than one mile, the correlations coefficient between forward scatter and transmissometer measurements was about 0.91 with a standard error of estimate of 26 percent. The disparities between simultaneous measurements were caused primarily by high frequency fluctuations in fog density that were detected by the small volume measurements with the forward scatter instrument, but were smoothed out by the measurements of transmittance over a baseline of 500 ft. Additional comparisons of forward scatter measurements and transmittance measurements in winter snow situations gave results similar to those obtained in fog conditions. (Author)

TITLE: Visibility Improvement Graphs: A Synoptic Forecast Aid.

AUTHOR: Sabin, Robert C.
4th Weather Wing, Ent. AFB, Colo.

SOURCE: DDC AD-697 960 (November 1969)

ABSTRACT: The paper describes a new technique for producing a useful synoptic climatological forecast aid which is different from the conventional climatological product. Data is limited to a specific weather element (radiation fog) associated with a specific synoptic weather regime. Thus, it is probably the first true synoptic climatological forecast tool. Its superiority over aids which do not take the synoptic pattern into account is clearly evident. (Author)

TITLE: Determination of Atmospheric Transmissivity from Laser Backscatter Measurements

AUTHOR: Halsey, H. W.; Gray, E. L.
General Electric Co., Missile & Space Division, Philadelphia, Pa.

SOURCE: DDC-AD-715 550 (1966)

ABSTRACT: In the paper single ended and double telephotometers are analyzed in the light of the Mie theory for the scattering of light by isotropic spherical particles. It is shown that the double ended telephotometer has an inherent possibility of error when used to measure atmospheric transmissivity. The single ended telephotometer, on the other hand, offers the optimum technique for obtaining an error free measurement. The analysis of the single ended device is expanded and by deriving a relationship between the transmissivity the intensity of light backscattered from the atmosphere and the elements of the scattering matrix, it is shown that the atmospheric transmissivity can be predicted by examining the backscattered light from a pulsed light source. An experiment is performed in which a Q-switched ruby laser is used as the light source and atmospheric transmissivity is obtained by measuring the backscattered light. These measurements are compared with simultaneous transmissivity measurements taken on stars by conventional methods. (Author)

TITLE: Visibility Measurement for Aircraft Landing Operations

AUTHOR: Collis, Ronald T. H.; Viezee, William; Uthe, Edward E.; Oblanas, John
Stanford Research Institute, Menlo Park, Ca.

SOURCE: DDC-AD-716 483 (September 1970)

ABSTRACT: An experimental pulsed neodymium lidar system was modified and calibrated to obtain accurate data on atmospheric extinction properties in fog and low cloud conditions. The objective was to establish the theoretical and practical basis of a system for measuring slant visiblity conditions for aircraft landing operations. To operate in conditions of fog and low cloud the lidar system's dynamic range was extended to 50 dB by using a two-stage receiver system. In addition, the transmitter and receiver beams were made coaxial to make close-range observations. (Author)

TITLE: The Variability of Visibility in the Hanscom Mesonetwork: A Preliminary Assessment

AUTHOR: Chisholm, Donald A.; Kruse, Horst
Air Force Cambridge Research Labs., Hanscom Field, Mass.

SOURCE: DDC-AD-784 791 (June 1974)

ABSTRACT: A preliminary assessment of the temporal and spatial variability of visibility in the Hanscom mesonetwork has been conducted with approximately eight months (September 1972-April 1973) of data. The variability of measurements obtained from forward scatter visibility meters (FSM) was found to be greatest in radiation fog episodes and least in precipitation in both time and space. Time variability was found not to be greatly affected by local topography and to be less at 45 m than at 4 m above ground level. An examination of interpolation error, through the method of optimum interpolation, revealed an improvement in the error of about 20 percent when the distance between observation points is halved in advective situations and about 10 percent in radiation fog episodes. Relating the interpolation errors to the natural variability of visibility prescribed the prediction potential of the Hanscom mesonetwork for short range prediction experiments. (Author)

TITLE: An Objective Method for Alerting Forecasters of Potentially Low Visibilities at Travis, AFB, California

AUTHOR: Lund, Iver A.
Air Force Cambridge Research Labs., Hanscom Field, Mass.

SOURCE: DDC-AD-778 125 (1974)

ABSTRACT: Low visibilities during the morning hours are a common occurrence at Travis AFB, California in late fall and winter months. However, the temporal and spatial variability of visibility is so great that estimating the exact time and place low visibilities will occur is difficult. Objective procedures for alerting forecasters of impending low visibility conditions are under study. Eighty-six potential predictors observed at Travis and four surrounding stations were screened to estimate the lowest visibility that will be observed during the next six hours. The predictors selected appear to be in good agreement with physical reasoning. (Author)

TITLE: Effects of Various Runway Lighting Parameters Upon the Relation Between Runway Visual Range and Visual Range of Centerline and Edge Lights in Fog

AUTHOR: Haines, Richard F.
NASA Ames Research Center, Moffett Field, Ca.

SOURCE: DDC-AD-785 320 (December 1973)

ABSTRACT: Thirty six students and 54 commercial airline pilots were tested in the fog chamber to determine the effect of runway edge and centerline light intensity and spacing, fog density, ambient luminance level, and lateral and vertical offset distance of the subject from the runway's centerline upon horizontal visual range. These data were obtained to evaluate the adequacy of a balanced lighting system to provide maximum visual range in fog viewing both centerline and runway edge lights. The daytime system was compared against two other candidate lighting systems; the nighttime system was compared against other candidate lighting systems. The second objective was to determine if visual range is affected by lights between the subject and the farthest-most light visible through the fog. The third objective was to determine if college student subjects differ from commercial airline pilots in their horizontal visual range through fog. Two studies were conducted.

TITLE: Atmospheric Attenuation of Laser Radiation from 0.76 to 31.25/um

AUTHOR: McClatchey, Robert A.; Selby, John E. A.
Air Force Cambridge Research Labs., Hanscom Field, Mass.

SOURCE: DDC-AD-779 726 (January 1974)

ABSTRACT: High resolution atmospheric transmittance curves are presented for the spectral region 320 to 13,200/c_m (0.7576 to 31.25 micrometers). These spectra are useful as a guide for selecting laser wavelengths for atmospheric propagation studies in this spectral region. In addition, this report provides attenuation coefficients for those lines of the CO, HF, DF, and CO2 laser systems which suffer the least atmospheric attenuation. A new aerosol model is introduced here, taking into account recent measurements of the complex index of refraction of aerosol particles. (Author)

TITLE: Atmospheric Effects for Ground Target Signature Modeling. III. Discussion and Application of the ASL Scattering Model

AUTHOR: Gomez, Richard B.; Petracca, Carmine; Querfeld, Charles; Hoidale, Glenn B.
Army Electronics Command, Fort Monmouth, N. J.

SOURCE: DDC-AD-A009 722 (March 1975)

ABSTRACT: The aim of the atmospheric modeling project is to predict absorption and scattering effects of the atmospheric medium on the transmission of ground target electromagnetic (EM) signatures in the spectral region 0.4-14 micrometers, for a wide range of meteorological conditions. Special attention is being given to low visibility atmospheric states which can exist under battlefield conditions. Two important related aspects of the program are the atmospheric extinction and radiative transfer models. These models will be integrated into system performance models for the evaluation of terminal homing, surveillance, and target acquisition systems. This report will describe the Atmospheric Sciences Laboratory's (ASL) single scattering model, which was developed for input to multiple scattering codes for the determination of EM extinction caused by the atmospheric aerosol. Sample applications will be made to the cases of haze and dust.

TITLE: Development and Calibration of the Forward Scatter Visibility Meter

AUTHOR: Muench, H. Stuart; Moroz, Eugene Y.; Jacobs, Leo P.
Air Force Cambridge Research Lab., Hanscom AFB, Mass.

SOURCE: DDC-AD-783 270 (March 1974)

ABSTRACT: A new visibility instrument, the forward scatter visibility meter, has been developed. This report describes the development of the instrument, including the various field tests. Some thirty instruments have been operationally deployed in a network of automatic weather stations near L. G. Hanscom Field in Bedford, Mass. Comparisons between field instruments and transmissometers yield differences of about plus or minus 19 percent. Comparisons with visual observations show differences of plus or minus 34 percent and greater. Analyses of individual cases uncovered difficulties with the response time of observers and with ability to diagnose spatially varying visibility. The accuracy of visibility measurements is assessed and the report concludes by looking at the future of visibility instruments. (Author)

TITLE: Airborne Infrared Transmissometer Design Study, Subsystem Design Analysis Report

AUTHOR: Block Engineering, Inc., Cambridge, Mass.

SOURCE: DDC-AD-A009 991 (April 1975)

ABSTRACT: This report describes the design of an airborne instrument to measure the transmissivity of the atmosphere to infrared radiation at wavenumber resolutions between 0.5/cm to 20/cm at ranges between 300 and 50,000 feet. Discussed are the general design approach, the detailed study of that approach, and the development of an instrument based on that study. The instrument uses a Michelson type interferometer to modulate an infrared source and Cassergrainian optics to transmit the signal into the atmosphere. A target mounted retroreflector returns the radiation to receiver optics mounted parallel to and exactly alike the transmitter optics. One of three available detectors senses the total signal and appropriate electronics discriminate the modulated from the unmodulated signal. A Fast Fourier Transform of the resulting interferogram and appropriate geometric scaling result in a high resolution spectrum of atmospheric transmissivity.

TITLE: Comparison of Slant and Runway Visual Range Relationships for 100, 124, and 155 Feet

AUTHOR: Lewis, William
National Aviation Facilities Exp. Ctr., Atlantic City, N. J.

SOURCE: DDC-AD-A052 870 (April, 1978)

ABSTRACT: Ratios of slant visual range measured from heights of 100, 124, and 155 feet to horizontal visual range measured at 15 feet were computed for low-visibility regimes. These ratios were found to be related to the linear fog density profile expressed as the difference in horizontal atmospheric transmittance between the top (100-, 124-, and 155-foot) and bottom (15-foot) levels. It was determined that useful estimates of slant visual range could be provided through these relationships. The predictions would be most accurate when the visibility decreased with height (most common fog structure). A slight increase in accuracy would also be expected with decreasing slant height.

TITLE: Workshop on Atmospheric Transmission Modeling

AUTHOR: Corcoran, Vincent J.
Institute for Defense Analysis, Arlington, Va.

SOURCE: DDC-AD-A026 354 (December 1975)

ABSTRACT: This is a report on a workshop on atmospheric transmission modeling. The workshop was divided into a morning session in which papers relating to the topic were presented and an afternoon workshop that was divided into a physics and engineering session and a session on computer modeling. The purpose of the workshop was to bring together those people who have contributed to computer modeling of atmospheric transmission, those who use the programs, and those who have evaluated the programs so that a consensus could be obtained concerning present models, the problem areas, and what must be done to evolve a model or models that would be acceptable in the future. (Author)

TITLE: Atmospheric Transmission Measurement Program Report for 1 July Through 30 September 1976 (TQ 1976)

AUTHOR: Cosden, T.H.; Curcio, J.A.; Dowling, J.A.; Gott, C.O.; Garcia, D.H.
Naval Research Lab., Washington, D.C.

SOURCE: DDC-AD-A046 794 (September 1977)

ABSTRACT: A facility has been completed to measure atmospheric transmission by combining measurement techniques based on laser-line extinction, high-resolution Fourier spectroscopy, and gas filter correlation spectroscopy. Essential features of this measurement system are described, and initial measurements are presented of 0.1/cm-resolution atmospheric transmission using a 5-km overwater path at the Patuxent River Naval Air Station, Patuxent River, Maryland. Concurrent absolute transmission measurements at several DF laser wavelengths between 3.6 and 4.1 micrometers have been used or provide absolute transmission calibrations for the spectra. (Author)

TITLE: Extinction Coefficient Measurements on Clear Atmospheres and Thin Cirrus Clouds

AUTHOR: Guttman, A.
General Electric Company, Missile and Space Division, Philadelphia, Pa.

SOURCE: DDC-AD-828 644 (February 1968)

ABSTRACT: An experimental investigation was carried out to determine possible differences in visible light extinction properties of continental and maritime air. Urban, desert and oceanic atmospheres were probed by means of a stable photodiode radiometer using direct sunlight as the source. No major differences were found for the three locations. Experimental coefficients generally lie slightly below mode data, though significantly higher than would be expected from purely molecular scattering. Day-to-day variations of up to 30% were found. Results of similar extinction measurements on thin cirrus clouds show a slight increase in scattering coefficient in going from 4000 to 7000 A wavelength. (Author)

TITLE: A Portable Spectrophotometer for Geophysical Applications

AUTHOR: Roulet, Ronald R.
Washington Univ., Dept. of Atmospheric Sciences, Seattle, Wash.

SOURCE: NTIS AD-715 790 (Dec 70)

ABSTRACT: Specifications, design considerations, and construction of an advanced spectrophotometer are discussed. This spectrophotometer represents a significant improvement over existing light measuring instruments. It is designed to measure light intensities in the visible spectrum (0.4 - 1.1 microns) with a relative accuracy of 1%. Transmitted or scattered light can be measured as a function of wavelength and direction. The wavelength resolution is adjustable down to 100 A. A small remote pickup unit, consisting of a photodiode and a lens system, is connected to the instrument by optical fibers and allows measurements up to six feet from the instrumentation. Although the spectrophotometer can be used in any work where extreme wavelength resolution is not needed, it was primarily designed for experiments with ice and snow. (Author)

TITLE: Atmospheric Optical Environment

AUTHOR: Vatsia, Mishri L.
Army Electronics Command, Night Vision Lab., Fort Belvoir, Va.

SOURCE: NTIS AD-750 610 (September 72)

ABSTRACT: A knowledge of the fundamental optical properties of the terrestrial atmospheric environment is essential for solving various problems in the multidisciplinary field of visionics including the areas of vision, psychology, atmospheric physics, infrared physics, simulation, astrogeophysics, and electro-optical technology. The aim of the report is to generalize the recent work of the author and summarize the data from other worldwide sources published by the first quarter of the year 1972. The report included a treatment of the atmospheric radiation, the atmospheric transmission, and the transfer of contrast by the atmosphere. The fundamental characteristics of the daytime and nighttime radiation including some important recent measurements of the solar, twilight, and nightglow radiation spectra are presented. An extensive chapter on atmospheric transmission includes the fundamental properties of the terrestrial atmosphere and basic principles of atmospheric absorption and scattering. A fairly complete collection of the most important data on atmospheric transmittance in the 0.4 micrometer to 15 micrometers spectral region is presented. The effects of atmospheric turbulence on the propagation of imagery are described. A detailed analysis of the transfer of contrast by the atmosphere is presented, and its significance on the performance of electro-optical devices is emphasized.

TITLE: Study of the Transmission Spectrum of Fog in the Infrared Spectrum

AUTHOR: Malyshev, V. I.
General Dynamics/Astronautics, San Diego, Ca.

SOURCE: NTIS AD-668 901 (July 59)

ABSTRACT: The study deals with the transmission spectrum of fog droplets of 2-15 microns in the infrared spectrum. (Author)

TITLE: UV, Visible, and IR Attenuation for Altitudes to 50 KM, 1968

AUTHOR: Elterman, Louis
Air Force Cambridge Research Labs., Hanscom Field, Mass.

SOURCE: NTIS AD-671 933 (April 68)

ABSTRACT: An atmospheric attenuation model for the ultraviolet, visible, and infrared was developed in 1964, based on scattering (molecules and aerosols) and ozone absorption. Since then more measurements have been made and our knowledge of aerosol attenuation has widened. These circumstances result in attenuation model changes which are relatively unimportant for most exploratory calculations. In this paper the optical parameters are computed spectrally and with altitude as follows: (1) pure air attenuation parameters are determined by utilizing Rayleigh scattering cross sections with molecular number densities from the standard atmosphere; (2) ozone absorption parameters are derived based on Vigroux's coefficients applied to a representative atmospheric ozone distribution; (3) seven sets of aerosol measurements are compared and a profile of aerosol attenuation coefficients vs altitude is developed. Attenuation coefficients and optical thickness due to molecular, aerosol, and ozone attenuation are computed and tabulated individually so that the influence of each can be compared. The newly derived tabulations permit various exploratory calculations, including horizontal, vertical, and slant-path transmission at kilometer intervals to an altitude of 50 km, individually for each attenuating component or for overall atmospheric extinction (molecular + ozone + aerosol). (Author)

TITLE: Characteristics of a Signal Data Converter for a Multi-Runway Visibility Measuring System

AUTHOR: Ingrao, H. C.; Lifsitz, J. R.
Transportation Systems Center, Cambridge, Mass.

SOURCE: NTIS AD-744 873 (Oct 71)

ABSTRACT: The report summarizes the results of a task to define characteristics for a signal data converter for computing visibility values from inputs from several transmissometers with reference to several kinds of target lights (e.g. centerline lights, approach lights, edge lights, taxiing lights).

TITLE: Laser Beam Attenuation in the Lower Atmosphere

AUTHOR: Langer, R. M.
Bege (JRM) C, Arlington, Mass.

SOURCE: NTIS AD-604 735 (22 Nov 63)

ABSTRACT: Small angle spreading, aerosol scattering and molecular absorption are considered the important mechanisms for the weakening of a laser beam in the open atmosphere. Three different transmission laws are worked out for these three mechanisms. Both the physical principles and the numerical values encountered in the lower atmosphere are discussed and illustrated. Random density fluctuations in the turbulent atmosphere are discussed as the cause of small angular deflections in a narrow pencil of light. Beam attenuation due to atmospheric aerosol scattering is treated for an aerosol size distribution described by the sum of two inverse powers of the droplet radius. Laser beams can help find the parameters of such distributions. Molecular absorption is examined in terms of the narrow infrared lines of water vapour. An effort is made to present this difficult topic in as simple and useful a form as is compatible with the observational material. The formulae are designed to make it possible to estimate in detail how the atmosphere would weaken a laser beam under a wide variety of conditions. It is found that some effects are serious even at short ranges of a few meters, while in favourable circumstances, laser signals would not be drastically attenuated out to any practical distance in the lower atmosphere. (Author)

TITLE: Measurement of the Transparency of Fogs Produced in Experimental Equipment

AUTHOR: Volkovitskii, D. A.; Pavlova, L. N.
Foreign Technology Div., Wright-Patterson AFB, Ohio

SOURCE: NTIS AD-702 962 (6 Jan 70)

ABSTRACT: A description is given of equipment used to measure transparency of fogs in experimental installations. Measuring errors of transparency and determination of the meteorological visual range in fogs are given. (Author)

TITLE: Attenuation of Visible Light by Falling Snow

AUTHOR: O'Brien, Harold W.
Cold Regions Research & Engineering Lab., Hanover, N.H.

SOURCE: NTIS AD-702 905 (June 69)

ABSTRACT: The attenuation of visible light by falling snow was studied by making simultaneous attenuation measurements and snow concentration measurements. The attenuation coefficient was calculated from photometric measurements and from visual observations. Snow concentration in the air was evaluation by two methods: from Formvar replicas collected during the snowfall, and by mass accumulation of snow in collecting pans. The snowflakes were arbitrarily classified by crystal types according to their estimated fall velocity. It was found that the correlation between extinction coefficient (attenuation) and snow concentration was generally much higher by types than when all snowflakes were considered together regardless of crystal components and degree of riming. Two types, apparently improperly classified, displayed lower correlations than the overall group. When no fog is present during the snowfall, the experimental results coincide well with attenuation theory if a reasonable correction is applied to the values obtained in the measurement of snowflake diameters. Measurements of mass flux indicate that for a given intensity the attenuation caused by snow is in order of magnitude greater than that caused by the same mass flux of rain. (Author)

TITLE: Rain-Attenuation and Side-Scatter Measurements of Millimeter Waves over Short Paths

AUTHOR: Mink, James W.
Army Electronics Command, Fort Monmouth, N.J.

SOURCE: NTIS AD-A012 167/3ST (June 1975)

ABSTRACT: Results of rain-attenuation and side-scatter measurements at millimeter waves are presented that have been obtained with a shuttle-pulse technique. This technique requires a path length through rain of only a few meters, so that rainfall rate and drop-size distribution can be considered uniform along this path.

TITLE: Features of Tropospheric and Stratospheric Dust

AUTHOR: Elterman, L.; Wexler, R.; Chang, D. T.
Air Force Cambridge Research Labs., Hanscom Field, Mass.

SOURCE: NTIS AD-699 609 (16 Dec 68)

ABSTRACT: A series of 119 profiles obtained over New Mexico comprise aerosol attenuation coefficients vs altitude to about 35 km. These profiles show the existence of several features. A surface convective dust layer extending up to about 5 km is seasonally dependent. Also, a turbidity maximum exists below the tropopause. The altitude of an aerosol maximum in the lower stratosphere is located just below that of the minimum temperature. The colder the minimum temperature, the greater is the aerosol content of the layer. This relationship suggests that the 20-km dust layer is due to convection in tropical air and advection to higher latitudes. Computed averages of optical thickness show that abatement of stratospheric dust from the Mt. Agung eruption became evident in April 1964. Results based on seventy-nine profiles characterizing dust abatement indicate that above 26 km, the aerosol scale height averages 3.75 km. Extrapolating with this scale height, tabulations are developed for uv, visible, and ir attenuation to 50 km. Optical mixing ratios are used to examine the aerosol concentrations at various altitudes, including a layer at 26 km having an optical thickness 0.001 for 0.55-microns wavelength. (Author)

TITLE: Clear Air Turbulence Detector

AUTHOR: Dahm, W.K.; Delgrego, D. J.; Goldstein, I.; Huffaker,R.M.; Jelalian, A.V.
NASA Marshall Space Flight Center, Huntsville, Ala.

SOURCE: NTIS N75-15028/4ST (patented 24 December 1974)

ABSTRACT: A system to be employed by an aircraft for the detection of clear air turbulence is described. The system employs a laser light beam which is directed ahead of the aircraft along the flight path. The portion of the light reflected back to the aircraft by atmospheric aerosol is detected and analyzed for Doppler shift. The velocity and intensity of the turbulence is determined by the type and amount of the light reflected.

TITLE: Atmospheric Propagation in the Middle-Infrared and at 8-14 Micrometers

AUTHOR: Stacey, J.; Arnold, J.
Technology Service Corp., Santa Monica, Ca.

SOURCE: NTIS AD-915 878/3ST (28 Sep 73)

ABSTRACT: This study considers the problems of propagation through the lower troposphere in the middle-infrared and in the 8 to 14 micrometer regions of the spectrum. The atmospheric constituents that scatter and absorb energy at these wavelengths are identified and the losses are calculated for several air-to-ground transmission paths. Examples of the atmospheric transmission losses are calculated for several passive sensor bandpasses and for a radar at 10.59 micrometers. In these examples, the atmospheric constituents that contribute to the total propagation loss over the sensor bandpass are individually identified and the accumulated losses are separately reported as a function of slant range. The performance for active and passive sensors is calculated and plotted for a host of weather conditions. Variations in rain rates, fog densities, and haze visibilities are introduced to demonstrate the relative degradation to the S/N for the sensor system. Aircraft measurements of atmospheric constituents are examined to determine if an empirical relationship exists between haze visibility and slant-path transmittance. Empirical expressions for haze attenuation are derived for selected wavelengths in the middle-infrared region and at 10.59 micrometers. Attenuation from common chemical smokes is estimated.

TITLE: Visibility Range in the Presence of Various Meteorological Phenomena

AUTHOR: Dovgyallo, Y. N.
Kanner Leo) Associates, Redwood City, Ca.

SOURCE: NTIS N73-21525 (April 73)

ABSTRACT: The application is made of a local statistical study of atmospheric transparency to the determination of the recurrence interval of various gradations in the meteorological visibility range in conditions of fog, haze, snowfall, snow storms, rain, and drizzle. It is found that the visibility is impaired most by fog, snow storms, and rainfall., in this order. (Author)

TITLE: Correlation between Atmospheric Backscattering and Meteorological Visual Range

AUTHOR: Fenn, Robert W.
Army Electronics Labs., Fort Monmouth, N.J.

SOURCE: NTIS AD-604 255 (June 64)

ABSTRACT: On the basis of present knowledge of the distribution of natural haze particles in the atmosphere, the relation between the back-scatter intensity and the visual range on the extinction coefficient has been analyzed. It can be shown that the various processes which cause the changes in visibility (increasing haze-particle number, change in haze particle-size distribution, etc.) result in rather different back-scatter conditions. Therefore, it cannot be expected that a unique relation between visibility and back-scatter signal can be found. A relation, visibility = f(back-scatter signal), with useful accuracy can be established only for specific atmospheric conditions; this relation, however, may be characteristic for certain geographical areas. These conclusions, derived from natural aerosol distributions and processes, are found to be in agreement with some published empirical data on scattering and visibility correlation. (Author)

TITLE: Atmospheric Transparency in the Visible and the Infrared

AUTHOR: Zuev, V. E.
National Science Foundation, Washington, D.C.

SOURCE: NTIS TT-69-55102 (1970)

ABSTRACT: Contents: Horizontal absorption of the infrared radiation in the atmosphere; Oblique absorption of infrared radiation in the atmosphere; Scattering of visible and infrared radiation in the atmosphere; Applicability of bouguer's law to aerosol scattering in the atmosphere; Atmospheric transparency in the visible and the infrared.

TITLE: Light Scattering and Particle Aggregation in Snowstorms

AUTHOR: Mellor, Malcolm
Cold Regions Research & Engineering Lab., Hanover, N.H.

SOURCE: NTIS AD-633 539 (Feb 66)

ABSTRACT: Attenuation of visible radiation by falling snow was studied by a method based on brightness contrast between topographic features and the adjacent sky. Extinction coefficient and visual range are related to snow density, and are compared with data for Antartic blizzards. Since attenuation depends more on the size and concentration of discrete particles than on the mass density of suspended snow, the process of particle aggregation and snowflake formation during fall is considered by collision theory, and an expression describing aggregation effects is developed. This offers an explanation for the relative constancy of particle concentration observed at ground level during snowfalls of varying intensity. Since there is no strong justification for relating extinction coefficient to snow density, an empirical correlation between extinction coefficient and precipitation rate is given for practical use. It is shown that visual range estimated by eye in hilly terrain may be less than the true value, since sky brightness is locally reduced over broad hilltops with low albedo. (Author)

TITLE: Visibility as an Estimator of Infrared Transmittance

AUTHOR: Mason, J.; Hoidale, G. B.
Army Electronics Command, Fort Monmouth, N.J.

SOURCE: NTIS AD-A031 040/9ST (July 76)

ABSTRACT: To assess the utility of visibility as an indicator of transmittance in the infrared, models depicting haze, fog, smoke, and dust were constructed such that all yielded identical transmittances at 0.55 micrometers (center of the visible spectrum), and transmittances at several infrared wavelengths (due to scattering only) were calculated. Results show that significant errors occur if visibility is relied upon. (Author)

TITLE: Further Studies of Space and Time Variations in Atmospheric Transmission Along Airport Runways

AUTHOR: Hage, Keith D.; Entrekin, Herbert D.
Travelers Research Center, Inc., Hartford, Conn.

SOURCE: NTIS AD-617 774 (March 65)

ABSTRACT: Space and time variations of transmission of visible light in the atmosphere during fog and precipitation are examined in detail as a preliminary step in the development of suitable short-period prediction techniques to be used at aviation terminals. This study is based primarily on data from three transmissometers along runways at John F. Kennedy International Airport, New York. The relative space scales of various classes of obstructions-to-vision are estimated and compared with similar estimates based on data from the National Aviation Facilities Experimental Center at Atlantic City, N. J. The apparent movement of the transmission field is derived and is related, insofar as possible, to advective and warm frontal movements. The potential predictability of linear translation of the transmission field is evaluated for periods of 5 to 25 minutes. Conditional frequencies of runway visual range for selected space and time lags are presented and compared with those found for Atlantic City Airport. (Author)

TITLE: The R.A.R.D.E. Portable Visibility Recorder

AUTHOR: Bestley, B.; Crockett, G. H.; Parry, E.
Royal Armament R&D Establishment, Fort Halstead, England

SOURCE: NTIS AD-691 588 (May 69)

ABSTRACT: This memorandum describes portable equipment developed to record variations in visibility when conducting field trials of night vision aids. The variation in the atmospheric transmission is measured by recording the apparent brightness of an incandescent filament lamp viewed over ranges which may be varied to suit the particular trial. The equipment has been used successfully out to a maximum range of 1000 metres. (Author)

TITLE: Optical Properties of the Atmosphere (Third Edition)

AUTHOR: McClatchey, R. A.; Fenn, R. W.; Selby, J. E. A.; Volz, F. E.; Garing, J. S.
Air Force Cambridge Research Labs., Hanscom AFB, Mass.

SOURCE: NTIS AD-753 075 (24 August 72)

ABSTRACT: A series of tables and charts is presented from which the atmospheric transmittance between any two points in the terrestrial atmosphere can be determined. This material is based on a set of five atmospheric models ranging from tropical to arctic and two aerosol models. A selected set of laser frequencies has been defined for which monochromatic transmittance values have been given. For low resolution transmittance prediction, a series of charts has been drawn providing the capability for predicting transmittance at a resolution of 20 wave-numbers. Separate sections are included on scattered solar radiation, infrared emission, refractive effects, and attenuation by cloud and fog. This third edition differs from the others in that the low resolution spectral curves for the uniformly mixed gases and in the short wavelength region for water vapor have been revised, providing some overall improvement in accuracy; and more importantly, an appendix has been added providing model data and equivalent sea level path data for the U.S. Standard Atmosphere, 1962. (Author)

TITLE: Infrared and Submillimeter Extinction by Fog

AUTHOR: Stewart, Dorothy Anne
Army Missile R&D Command, Redstone Arsenal, Ala.

SOURCE: NTIS AD-A045 181/5ST (July 14, 1977)

ABSTRACT: A thorough literature survey of fog drop-size distributions throughout the world is discussed, and data from 36 references are summarized. The review of an extensive list of over 100 references includes additional important information. Ranges of liquid water content and problems of relating this to visibility are examined. Changes in fog characteristics from place to place and from time to time are also considered, and the discussion includes small-scale spatial and temporal fluctuations.

TITLE: Calculation of the Attenuation Coefficients of 0.6-14 Micrometer Waves Passing through Fog

AUTHOR: Zelmanovich, I. L.; Lobkova, L. M.; Milyutin, E. R.
Foreign Technology Div., Wright-Patterson AFB, Ohio

SOURCE: NTIS AD-714 786 (8 Sep 70)

ABSTRACT: Precise and approximate equations are derived for use in determining the coefficient of attenuation alpha 1/km of electromagnetic waves in mists and fogs. The simplified equations are given in unabsorbed polydispersed aerosols and absorbed polydispersed aerosols. Comparative calculations were made for several laser wavelengths in the spectral windows of atmospheric transparency. The optical properties of the water drops used as sols, droplet sizes used, and the mean droplet radii were given. Results obtained in a given calculation using a M-20 electronic computer and those obtained in using given equations are tabulated. They indicate that the use of these approximate equations results in errors which are only about 18 percent larger than those derived from precise and tedious equations. Electromagnetic waves in the 10-12 mu spectra passed through fogs with minimal attenuation. In heavy, optically dense fogs (for short wavelengths) the coefficient of attenuation was not selective. (Author)

TITLE: A Comparison of Computed and Experimental Spectral Transmissions Through Haze

AUTHOR: Eldridge, Ralph G.
Mitre Corporation, Bedford, Mass.

SOURCE: NTIS AD-676 603 (July 68)

ABSTRACT: Spectral transmission through haze are computed using meteorological observations to specify aerosol scattering and water vapor, carbon dioxide, and ozone absorption. The computed spectral transmissions are compared with the appropriate experimental transmissions to evaluate the degree to which a natural spectral transmission can be simulated by a computed spectral transmission. The comparison indicates that the dominant atmospheric attenuating parameter is the absolute distribution of aerosols. (Author)

TITLE: Backscatter Signature Studies for Horizontal and Slant Range Visibility

AUTHOR: Brown, Richard T. Jr.
Sperry Rand Research Center, Sudburg, Mass.

SOURCE: NTIS AD-659 469 (May 67)

ABSTRACT: Analytical and experimental results of a study of a backscatter signature system for measurements indicative of horizontal and slant visual range are presented. The physics of the concept, including the relationships between characteristics of a time display of backscattered laser energy and the extinction coefficient of the visibility restricting scattering medium, also is discussed. Data obtained simultaneously from the backscatter signature system and conventional transmissometers were used to investigate the effectiveness of the measuring technique and the changes in the operating characteristics obtained by varying the system configuration. The backscatter signature measurements, converted to atmospheric transmittance, compare well with those of the transmissometer, considering certain incompatibilities between the measuring systems. The optimum system configuration and design parameters are discussed with respect to the design of a backscatter signature system. (Author)

TITLE: Visibility Calculations for Microphysical Computer Models

AUTHOR: Johnson, David B.
Environmental Prediction Research Facility (Navy), Monterrey, Ca.

SOURCE: NTIS AD-776 228/9 (June 1972)

ABSTRACT: The calculation of visual range in microphysical computer models is discussed. Part I combines material from a number of references into a single discussion of background theory. Part II discusses applications of the theory to actual computer models and presents sample FORTRAN listings. Specific topics include: calculation of visual range in a cloud of either water drops or ice crystals; and, simulation of slant visual range in a multi-level model. A FORTRAN subroutine for calculation of the scattering area coefficient is appended. (Author)

TITLE: Design and Evaluation of Visibility Sensor/Runway Visual Range Computer Interface Circuitry

AUTHOR: Newcomb, James E.
National Aviation Facilities Exp. Ctr., Atlantic City, N.J.

SOURCE: NTIS AD-A051 175/8ST (January 1978)

ABSTRACT: Runway visual range (RVR) is an aviation visibility value obtained by utilizing a special purpose signal data converter. Atmospheric transmittance, one of the processing parameters used, is provided by a National Bureau of Standards type transmissometer that samples clarity of the atmosphere by measuring the amount of incandescent light from a known source remaining in the beam after passing through a baseline distance of 500 or 250 feet. New types of visibility sensors are now being produced that operate on a light-scattering principle rather than attenuation. These new types of sensors are being considered as alternatives to the NBS transmissometer. If found suitable, these new sensors will require signal conditioning circuitry in order to operate in conjunction with existing, standard-type RVR computers. This report describes the design and testing of such an interface circuit to permit use of the EG and G model 207 Forward Scatter Meter (FSM) with the RVR computer. It was concluded that the circuit design does provide accurate interface between the EG and G model 207 FSM and FA-7871-type signal data converters.

TITLE: Mie-Lidar

AUTHOR: Tenkate, R.; Lamberts, C. W.
Physics Lab RVO-TNO, The Hague, Netherlands

SOURCE: NTIS N77-10757/1ST (August 1975)

ABSTRACT: Backscattering from aerosols was studied both experimentally and theoretically. Using a low power lidar installation, backscattered light can be detected up to a distance of 3 km. The transmission of the homogeneous parts of the atmosphere, for different wavelengths, can be determined from the received signal. The possibilities for determining particle sizes from the backscattering at several wavelengths seems to be restricted to specially shaped particles. This result however is of importance for the evaluation of atmospheric limitations imposed on far-infrared equipment. (Author)

TITLE: Atmospheric Transmission Measurement Program and Field Test Plan

AUTHOR: Dowling, James A.; Horton, Richard F.; Trusty, Gary L.; Cosden, Thomas H.; Haught, Kenneth M.
Naval Research Lab., Washington, D.C.

SOURCE: NTIS AD-A049 186/OST (30 November 1977)

ABSTRACT: An atmospheric measurement program combining laser-line-extinction, Fourier-spectroscopy, and gas-filter-correlation-spectrometer experiments is described. A brief summary of the NRL experimental propagation effort since 1970 is presented followed by an abbreviated discussion of the current status of linear propagation modeling. Objectives of the current NRL atmospheric transmission program are stated. An experimental field test plan is presented followed by detailed information contained in several appendixes concerning procedures and facilities for laser-line-extinction measurements and calibrations, scanning-Michelson-interferometer experiments, gas-filter-correlation-spectrometer measurements, meteorological and aerosol data acquisition, and on-site data processing. Information concerning project staffing and a schedule for preparation and performance of a field experiment to be carried out at the Patuxent Naval Air Station, Patuxent River, Md., are contained in two final appendixes. (Author)

TITLE: Far Infrared and Submillimeter Scattering. II. Attenuation by Clouds and Rain

AUTHOR: Deirmendjian, D.
Rand Corporation, Santa Monica, Ca.

SOURCE: NTIS AD-A011 644/2ST (February 1975)

ABSTRACT: The report provides reliable estimates of the attenuation of radiation at such wavelengths through various types of water clouds as well as moderate and heavy rain. The attenuation properties of hydrometeors are of prime interest. In particular, the use of some new cloud- and raindrop-size distribution models that were developed for this study is described and justified. Attenuation computations for these models are presented, and these estimates are then analyzed and compared with other work and with observation. Results imply that interference with current tactical air operations by clouds and fog can be substantially reduced if target acquisition and munitions guidance systems that operate at frequencies near 230 GHz can be developed.

TITLE: Atmospheric Transmittance from 0.25 to 28.5 Micrometers: Support LOWTRAN 3B (1976)

AUTHOR: Selby, J. E. A.; Shettle, E. P.; McClatchey, R. A.
Air Force Geophysics Lab., Hanscom AFB, Mass.

SOURCE: NTIS AD-A040 701/5ST (November 1, 1976)

ABSTRACT: This supplement provides several additions and updates to the LOWTRAN 3 computer code, which can be used to calculate the transmittance of the atmosphere from the ultraviolet to the middle infrared portion of the spectrum (0.25 to 28.5 micrometers) at a spectral resolution of 20 cm. The major additions are the inclusion of water vapor continuum attenuation in the 3.5 to 4.2 micrometers region, and a temperature dependence to the H2O continuum attenuation coefficient in both the 4 micrometers and 10 micrometers regions. The contribution of foreign gas broadening in the 8-14 micrometers region has also been reduced. Four aerosol models are included in this supplement. These include three boundary layer aerosol models for maritime, urban, and rural conditions in the lower 2 km of the atmosphere, and a tropospheric model for use mainly above 1 or 2 km altitude. The rural model is a replacement for the average continental model presently in LOWTRAN 3. A temporary provision is also given to accommodate fog conditions when the visual range falls below 2 km. (Author)

TITLE: Fog Droplet Growth and Precipitation-Rate Measurements with an Ultra-Violet Wavelength Transmissometer

AUTHOR: Bollay Associates, Inc., Santa Barbara, Ca.

SOURCE: NTIS AD-692 436 (31 Jul 67)

ABSTRACT: This report describes measurements of radiation fog droplet growth and precipitation-rate. The instrument used was an ultra-violet wavelength transmissometer developed previously by the Federal Aviation Agency as part of its research activities in airfield instrumentation. Measurements were made at Portland (Oregon) International Airport in FY66 and Corvallis, Oregon in FY67. The fog droplet growth measurements were inconclusive, apparently because of an invariance in the .1 to 1.0 micrometers droplet size spectrum as radiation fog forms in continuously saturated air. Precipitation-rate power spectra are found to be similar to those obtained with conventional rain-rate gage data. (Author)

TITLE: AMOS (ARPA Maui Optical Station) Seeing Quality Measurements

AUTHOR: Greenwood, Darryl P.; Tarazano, Donald O.; Haugen, Duane A.; Kellen, Paul F.; Miller, Merlin G.
Rome Air Development Center, Grifiss AFB, N.Y.; DARPA, Arlington, VA

SOURCE: NTIS AD-A021 943/6ST (January 1976)

ABSTRACT: During the month of August 1974, a series of experiments was conducted at the ARPA Maui Optical Station (AMOS) on Mt. Haleakala, Maui, Hawaii. The objectives were to quantify astronomical seeing conditions, and to determine if the seeing quality has been degraded by the presence of the site structures. Instruments used were an acoustic sounder (to probe the altitudes of 100 to 1000 ft), finewire microthermal probes (to measure local turbulence in and around the domes) and a Hartmann sensor (to provide integrated strengths of turbulence for the entire atmosphere). According to fine-wire probe data, local turbulence can be on occasion a significant factor in degrading seeing. These sensors noted some thermal contamination from one of the domes which was in a nearly operational configuration. The acoustic sounder indicated that the strengths of turbulence in 100 to 1000 ft altitude are not sufficient to degrade seeing. Finally, the Hartmann device recorded significantly more degradation than was seen by either of the other two probes. It is speculated that there is significant turbulence at high altitude temperature inversions such as at the tropopause.

TITLE: A Method to Obtain Diffuse Reflectance Measurements from 1.0 to 3.0 micrometers Using a Cary 17I Spectrophotometer

AUTHOR: Gillespie, James B.; Lindberg, James D.
Army Electronics Command, Fort Monmouth, N. J.

SOURCE: NTIS AD-A035 031/4ST (November 1976)

ABSTRACT: This report describes a way to perform diffuse reflectance measurements over the 1.0 to 3.0 micrometers spectral interval by using a Cary 17I Spectrophotometer equipped with inexpensive standard accessory cell-space integrating spheres. The method involves coating the cell-space spheres with a powder of pure grade quenched sulfur with carbon disulfide used as a solvent and making a minor alteration in an electronic amplifier. A spectrum of ground gypsum crystal in the 2.6 to 3.0 micrometers spectral region and a spectrum of a layer of Hectorite clay in the 1.0 to 3.0 micrometers spectral region are presented to illustrate the applicability of the above technique for making diffuse reflectance measurements in the near infrared.

TITLE: Far Infrared and Submillimeter Wave Attenuation by Clouds and Rain

AUTHOR: Deirmendjian, D.
Rand Corporation, Santa Monica, Ca.

SOURCE: NTIS AD-A021 947/7ST (April 1975)

ABSTRACT: Newly determined optical constants for water at far infrared and submillimeter wavelengths are used to estimate water cloud and rain attenuation over the wavelength range between 12 micrometers and 2cm. For this purpose new analytic dropsize distribution models simulating fog, nimbostratus cloud, and rain corresponding to rainfall rates of 10 and 50 mm per hour are set up. The corresponding volume extinction and absorption coefficients are computed according to polydisperse Mie scattering theory at specific wavelengths and presented in tables and graphically in plots for purposes of interpolation. It is found that cloud extinction may exceed 50 nepers per kilometer in the wavelength region less than or approximately equal to 100 micrometers region whereas for wavelengths longer than 200 micrometers, under near saturated conditions, water vapor absorption should be the dominant attenuator. The results also suggest that, in the presence of non-precipitating water clouds or fog there may be a relative transmission 'window' centered around wavelength 1.3 mm.

TITLE: Spectral Absorption Characteristics of the Major Components of Dust Clouds

AUTHOR: Flanigan, Dennis F.; DeLong, Harry P.
Edgewood Arsenal, Md.

SOURCE: NTIS AD-712 989 (Sep 70)

ABSTRACT: It is well known that dust clouds selectively absorb radiation in the 700 to 1300/reciprocal cm. atmospheric window region. Studies have shown that dust clouds are composed of the same minerals as surface soils, although in different proportion. Seventy soil samples were examined from a number of locations around the world to determine their compositions and spectral characteristics. The results indicate that there are five major components that selectively absorb radiation in the 700 to 1300/reciprocal cm. region. These are three clay minerals, silica, and calcium carbonate. Absorptivety coefficient spectra of representative soil samples are given in the body of the report, and transmission spectra of all soil samples are given in the appendix. (Author)

TITLE: A 50-cm Fog Disdrometer

AUTHOR: Faller, Harlan L.
South Dakota School of Mines and Technology, Institute of Atmospheric Sciences, Rapid City, S.D.

SOURCE: NTIS AD-727 184 (May 70)

ABSTRACT: A description is given of an ultra-sensitive disdrometer to be used in the analysis of fogs and aerosols. This device operates on a wavelength of 0.9 microns over a 50-cm path and utilizes the principles of optical transmission and scattering of light by small particles. It was originally developed to analyze aerosols composed of particles as small as 1 micron and as large as 14 microns in diameter. The primary region of operation is in the 97.0 to 99.9 per cent transmission coefficient range with an ascribed sensitivity of 4 parts in 100,000. The device is capable of determining the average size and average density of particles per cubic centimeter of light to moderate fogs. Other suggested uses of this disdrometer include the investigation of smokes, hazes, and air pollution. (Author)

TITLE: The Meaningful Use of the Secchi Disc

AUTHOR: Williams, Jerome
Johns Hopkins Univ., Chesapeake Bay Institute, Baltimore, Md.

SOURCE: NTIS AD-679 166 (Nov 68)

ABSTRACT: The Secchi Disc is examined in terms of a target seen by the human eye under threshold contrast conditions. Results indicate that the Secchi Disc Reading is related to both the extinction coefficient and the beam transmittance coefficient. There appears to be no way to separate the two from the use of the Secchi Disc alone. In addition, if these readings are to have any meaning at all it is strongly indicated that an optical filter be placed in the system when readings are taken. Special colored glasses are suggested for this purpose. (Author)

TITLE: The Effect of Atmospheric Scattering on Optical Beam Intensity at Low Visibility

AUTHOR: Miler, M.: Chomat, M.
Foreign Technology Division, Wright-Patterson AFB, Ohio

SOURCE: NTIS AD-850 030/8ST (November 21, 1968)

ABSTRACT: Atmospheric attenuation of an optical beam caused by scattering in fog was measured using an incoherent GaAs diode emitter in the 900 nm infrared band. The beam was concentrated to about 10 angular minutes by a 1-kHz moderator. The receiving photomultiplier and interference filter were placed at a distance of 600 m (through thick fog) across an artificial lake. Three forms of light scattering are described and a formula is presented for visibility based on the attenuation coefficient and wavelength for Rayleigh scattering. A formula for attenuation is given, and other experimental findings, such as the effect of size of moisture droplets, of nonhomogeneous waves of thick fog, and of homogeneous fog cover, are given. In homogeneous fog, minimum visibility was 300 m and the maximum attenuation 20 db/km; in extremely dense fog visibility was 50 m and attenuation 180 db/km, which indicates why optical navigation signals are not reliable under such conditions. (Author)

TITLE: Experimental Observations of Forward Scattering of Light in the Lower Atmosphere

AUTHOR: Curcio, J. A.; Drummeter, L. F. Jr
Naval Research Labs., Washington, D.C.

SOURCE: NTIS AD-607 487 (30 Sep 64)

ABSTRACT: The report deals in part with the experimental results from seven measurements on the forward scattering of light by the atmospheric aerosol. In addition, considerations of the problem of detecting forward scattered light in the daytime show that estimated results agree with the available experimental data. Considerations of the feasibility of using over-the-horizon propagation as a communications link leads to the estimation that communication between fixed points at Morse code rates is currently feasible over ranges of the order of 50 km in the daytime for meteorological ranges of 16 km or more, using a narrow-beam projector as source. Ship-to-ship communication would require sources of very high power or precise stabilization and pointing of exising high-intensity searchlight sources. (Author)

TITLE: Field Testing and Evaluation of Methods for Measuring Visibility

AUTHOR: Cwalinski, Russel; Lansinger, John M.; Tank, William G.
Northwest Environmental Technology Labs., Inc., Bellevue, Wash.
National Environmental Research Center, Research Triangle Park, N.C.

SOURCE: NTIS PB-251 548/4ST

ABSTRACT: This report presents the results of a 3-month field study which was conducted to evaluate four methods for determining visibility. Three of the methods employed instruments to obtain visibility related measurements: a telephotometer measuring contrast between 'black' targets and the horizon sky; a transmissometer measuring light extinction over a folded horizontal path of approximately one mile; two integrating nephelometers measuring light scattering by aerosis in a local volume of air. One nephelometer was operated at a fixed location throughout the duration of the field tests and the other on occasions at random locations. The fourth method used a trained observer estimating visibility in four compass directions, and this method was used as a standard for comparison. Measurements were made under a variety of meteorological conditions and results are classified by the range of relative humidity under which they were obtained. The results of this project identify the telephotometer as the best choice of instrument for routine estimates of daylight visibility as an indicator of air quality.